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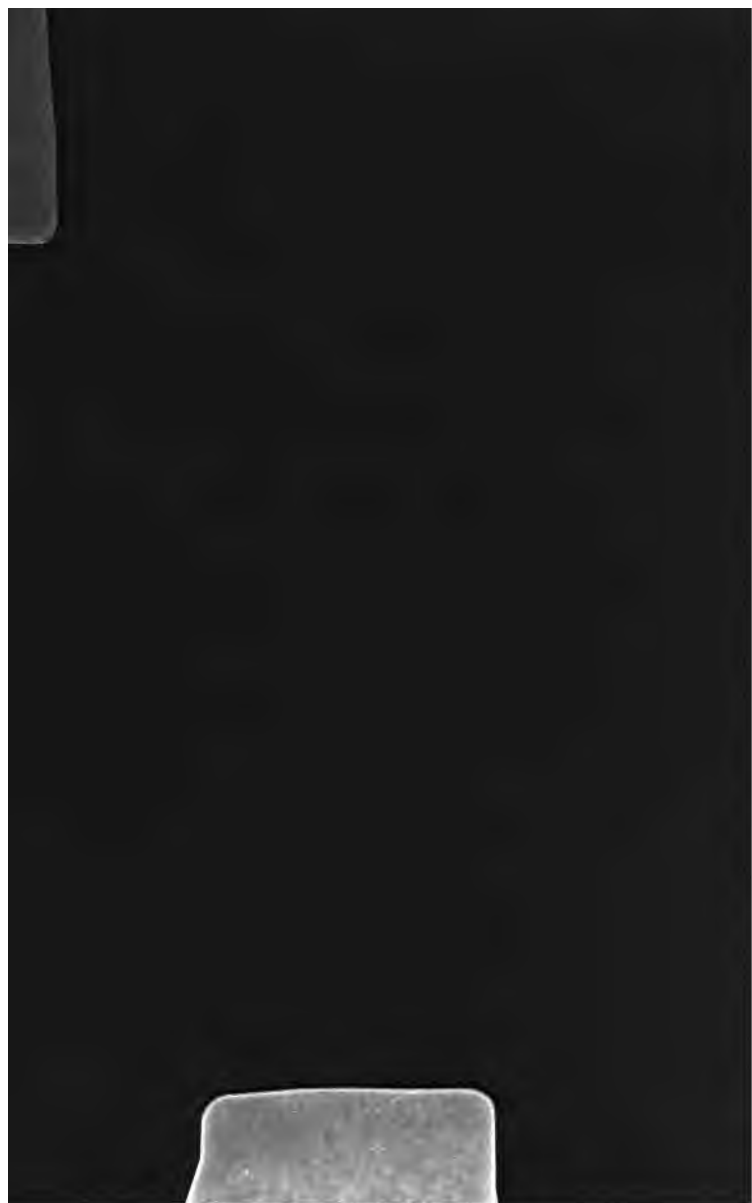
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AN
AGRICULTURAL
NOTE-BOOK

W. C. TAYLOR.





AN

AGRICULTURAL NOTE-BOOK

LONDON
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AN
AGRICULTURAL NOTE-BOOK

TO ASSIST CANDIDATES IN
PREPARING FOR THE SCIENCE AND ART AND OTHER
EXAMINATIONS IN AGRICULTURE

BY
WILLIAM CHARLES TAYLOR

PRINCIPAL OF THE AGRICULTURAL COLLEGE
ASPATRIA VIA CARLISLE

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PREFACE.

THE contents of the following pages have been found useful to all my pupils, especially to those who have been successful in gaining scholarships of the Royal Agricultural Society of England, bursaries of the Highland Agricultural Society of Scotland, and certificates and prizes from the Science and Art Department; and it is at their earnest request that I have been persuaded to publish my notes, hoping they may prove as valuable in the future as they have done in the past.

As a teacher, I have always found it convenient for the memory to analyse the various scientific subjects, grouping under each head the several particulars respecting it, and to express these in as terse a form as possible. This plan I have followed in this little work.

W. C. TAYLOR.



CONTENTS.



PART	PAGE
I. THE SCIENCE OF AGRICULTURE	1
II. SEEDS, CORN, AND DISEASES	14
III. MANURES, NATURAL AND ARTIFICIAL	27
IV. ROOT CROPS	46
V. GRASSES AND CLOVERS	56
VI. LIVE STOCK	73
VII. MISCELLANEOUS ANALYTICAL TABLES &C.	83
VIII. QUESTIONS FOR EXAMINATION	89

THE
AGRICULTURAL NOTE-BOOK.

PART I.

THE SCIENCE OF AGRICULTURE.

DEFINITIONS AND TERMS.

Its **Definition**.—Scientific truths taught by the practice of agriculture. The practice of the farm teaching the science. The laws of agricultural science best learnt when thus taught, and lead to improvements in the application of science to farm practice.

Its **Sister Sciences**.—Chemistry, botany, geology, physiology. Experience on the farm, like the rudder to the ship. Scientific knowledge, like the compass.

Its **Character** in the soil, as temper, will, and disposition. These to be noted; success of farmer depending much on his knowledge of above. *Hungry, sick, grateful, obstinate, kindly, tender, &c.*

It has a history of its own, which has been revealed by the results of practical experiments.

TERMS DESCRIBING SOILS.

1. **Hungry**.—Constantly in want of food. Sands and gravels have no power of holding manures; an absence of double silicates and ferric oxide; short supply of organic matter improved by adding clay, where practicable, and vegetable matter.

2. **Tough and Obstinate**.—Contain a great quantity of clay. Improved by drainage and autumn ploughing, and application of rough manure.

3. **Tender.**—Hard and baked. Improved by rain, drags, and harrows at right time ; add organic matter.

4. **Kindly and Grateful.**—Generally loamy ; pleasant to manage.

5. **Sick.**—Various causes.

1. Presence of some objectionable body.

2. Absence of some plant requirement. Improved by drainage ; deep autumn cultivation.

6. **Fertility** of soil determined by that portion of plant food least abundant.

SOILS.

Origin.—Decay of rocks, like the wearing of stone-work through geological periods. Earth formerly was

Primitive rocks, now divided into secondary, tertiary, and so on, each stage modified in character by influences of animal and vegetable life, so we ought to find in primitive rocks materials similar to the soils in our fields ; consists of three distinct groups—granite, syenite, trap.

	Symbol	Granite	Trap	Syenite
Silica	SiO ₂	72.0	43.0	59.8
Alumina	Al ₂ O ₃	16.0	14.0	16.8
Ferrous Oxide	FeO	1.5	15.3	7.0
Lime	CaCO ₃	1.5	12.1	4.5
Magnesia	MgO	.5	9.1	2.6
Potash	K ₂ CO ₃	6.0	1.3	6.6
Soda	Na ₂ CO ₃	2.5	3.9	1.3
Phosphoric Acid	H ₃ PO ₄	} traces	traces	traces
Sulphur	S			
Manganese	Mn			
Moisture	H ₂ O	—	1.3	1.4
		100.0	100.0	100.0

The *Primitive rocks* differ from materials yielded by decay, which is accomplished by *oxygen* (O) and *carbonic acid* (CO₂) gases, invisible and transparent. Both attack rocks and metals, however hard ; seen in the mould board of the plough reducing it to a powder without noise. *Temperature* and *water* other two *agents* acting on the *traitor's iron* and *potash*, loosening particles from the hard rock. *Frost* increases bulk of water in crevices, then breaks off rocks. Constantly at work ; slow progress with hard, but quicker with softer rocks. These agents are the *friendly helpers* to the farmer.

Peat Bogs, only exception to above formation, composed of *vegetable matter*. Decay of aquatic plants in stagnant water ;

accumulate till the water surface is reached ; hence height of peat bog determined by overflow edge of stagnant basin.

Character of soils influenced by original rocks. Rocks are modified in character according to their materials. If rocks be hardened, sediment when broken forms fine clay ; so soils may widely differ from parent rock ; no constancy in condition. This variation compels

Power to distinguish soils with accuracy to classify them. Sand and clay selected to determine the groups, first of the sea-shore, second potteries.

Sand.

1. Falls rapidly to the bottom.
2. When wet, hard to the touch.
3. Little cohesion ; unable to mould it definitely.
4. Cuts hard and gritty.
5. Quickly impervious to water.
6. Firm to the foot.

Clay.

1. Renders water muddy ; settles slowly.
2. Soft to the touch.
3. Great cohesion ; easily moulded.
4. Cuts soft and greasy.
5. Keeps water on its surface.
6. Slippery to the foot.

Classification of soils, sand and clay as heads of groups in the

Mechanical Analysis.—Take small quantity from four or five places in the field, mix thoroughly, separate stones, well crush soil, pass through $\frac{1}{8}$ -inch sieve ; weigh certain quantity, soak it in water, boil it mixed with more water, well stirred ; the muddy water quickly poured to another glass, washed again and again till no muddy water appears, which, however, has been preserved, and sandy portion in another vessel ; allow mud to settle, pour clear water away ; dry both and then weigh each.

	Per cent.
Sands contain from . . .	80 to 100 of sand.
Sandy Loams	60 to 80 ,,
Loams	40 to 60 ,,
Clay Loams	20 to 40 ,,
Clays	0 to 20 ,,

Chemical Analysis teaches the **Active** and the **Dormant** matters which contain the fertilising substances, and the composition of each, offering sound and reliable information as to the farmer's course of crops, show him the deficiency to be supplied by manures. Plants require variety of different substances for their full and perfect growth. No one body of any imme-

diate use, unless dissolved in water, helped by CO_2 or organic acid. Water assisted by these weak acids is the vehicle of the plant food.

Plant Food.—That portion of the soil which will dissolve in rain water or very weak acid and enter into plant.

Dormant matter into active.—An important problem. Enlist friendly helpers O , CO_2 , frost, H_2O , which increase amount of surface, H_2O carrying O and CO_2 to solve plant food and accomplish a work equal to the purchase of so much manure. Give them every opportunity by

Autumn ploughing, which gives following results :—

1. Exposes land thoroughly to action of air.
2. Promotes decomposition of sour and acid matter, changing it into plant food.
3. Changes dormant into active soil.
4. Loosens soil for growth of seed.
5. Increases crop at trifling cost.
6. Changes useless constituents into useful.
7. Land pulverised by frost, which gives much work to other agents.

Drainage.

1. Removes stagnant water.
2. Lets air into the earth to prepare plant food.
3. Exposing land surface to O and CO_2 .
4. Rapidly improves productive powers of the land.
5. May be done by subsoiling.
6. Sweetens the soil and changes organic acid to CO_2 .
7. Changes FeO into Fe_2O_3 , ferrous into ferric oxide.
8. Helps the land to imbibe H_3N from atmosphere.
9. Raises temperature of soil by admitting warm air and making it more productive.
10. Improves the working qualities of the land and saves horse labour.
11. Brings earlier harvest.
12. Over drainage counteracted by capillary force.

Organic matter present in all good soils ; its presence proved by burning the soil, the result lighter than original weight. **Origin**—lowest order of vegetation upon rocks, which die and their remains become intermixed. This carried on for a time, then plants of higher order ; then vegetable matter produced mixed with remains of animal or vegetable decay ; hence the term. Consists of matter drawn from atmosphere. Cultivation increases it, especially certain crops, as clover, allowing to remain long in grass. Plough in green crops.

Duties Performed by organic matter in soil :

1. Gives freedom to soil.
2. *Helps plant roots to penetrate.*

3. Destroys the firmness of clays.
4. Strengthens the firmness of sands.
5. Useful in all soils, except peaty.
6. Increases the power to absorb moisture and gaseous matter from the atmosphere.
7. Determines the productiveness of sands and gravels.
8. Preserves moisture in No. 7.
9. Holds manures and plant food in hungry soils.
10. Prepares the mineral matter for assisting in the growth of the crop.
11. Renders dormant matter available for plant growth.
12. Its presence always necessary.
13. Restores its mineral matter in a form favourable for growing crops.
14. Encourages growth of clover to preserve much of the manure, which is built up in the plant.
15. Decay of clover root gives fertilising matter gradually.

Analysis of Soils.—This is necessary to understand, so as to remedy sick soils. Soil is a mixture of different substances, each contributing its own influence—a most irregular mixture of decomposed rocks and organic matter differing greatly from each other :—

Chemical Substances	Chemical Symbol	Barren Sand	Moorland Soil	Rich Clay Soil	Good Loam	Ca'lca-reous	Fertile Soil
Potash	K_2CO_3	trace	·06	2·8	·80	—	1·03
Soda	Na_2CO_3	trace	—	1·44	1·20	—	1·97
Ammonia	H_4N	—	—	—	—	—	·06
Lime	$CaCO_3$	trace	·13	·83	1·28	52·33	4·09
Magnesia	MgO	trace	·03	1·02	1·12	·31	·13
Peroxide of Iron	Fe_2O_3	} 2·00	·64	{ 4·87	3·41	} 2·86	{ 9·04
Protoxide of Iron	FeO						
Protoxide of Manganese	MnO	trace	—	—	—		
Alumina	Al_2O_3	·50	·78	14·04	3·58		
Phosphoric Acid	H_3PO_4	trace	·11	·24	·38	trace	·47
Sulphuric Acid	H_2SO_4	trace	·02	·09	·09	trace	·90
Carbonic Acid	CO_2	—	—	—	·92	44·70	6·08
Chlorine	Cl	—	·01	·01	trace	—	1·24
Soluble Silica	—	—	—	—	—	—	2·34
Insoluble „ Clay	—	—	—	61·2	} 81·26	} 26 {	57·65
„ „ Sand	—	96·00	81·50	—			
Organic matter	—	1·60	16·70	8·55	2·43	—	12·00
Water or loss	H_2O	—	·02	4·91	3·23	—	1·00

The substances found in soils more than in primitive rocks are owing to additions made by the atmosphere, the sea, and the influences of animal and vegetable life.

Silica, most common and most abundant in quartz, flint. Sand of no agricultural value.

Silicate of Alumina forms the great bulk of the clays—insoluble agricultural clays, so-called ; ought to be pottery clays—

only valuable for plants in the presence of the essential elements.

Phosphoric Acid, weak at low, but powerful at high, temperatures; valuable constituent to enable the crops to be of proper feeding value to form bone.

Organic Matter.—Its presence only one condition of fertility. Composition varies: formed of C, H and O, and a series of dark-coloured earths named Organic Acids.

Humic Acid,	C,	combined with	H ₂ O
Ulmic Acid,	C,	„	„
Geic Acid,	C,	„	„
			H ₂ O + H
			H ₂ O + O

Decomposition of nitrogenous bodies form H₃N and HNO₃.

Density of Soils.

Sand when dry weighs	100 lbs.	per cubic foot.
Loam „ „	95 „	„ „
Clay „ „	75 „	„ „
Peaty soils „	weigh 30 to 50 „	„ „

The greater the density, the less injury by treading. Distinction between weight of soils and light and heavy: latter refer to horse-power required in ploughing.

Mechanical Division.

Clays, fine division, helped by organic matter and chalk.

Sands, Coarse, containing stones, grit, earthy matter, in gradation.

Stones exert mechanical influence:—

1. Favour admission of air and moisture.
2. Increase friability of character.
3. Shield from sun's rays.

In some cases may be cracked and left on land.

Fairly fine division brings—

Supply of water from low level, and holds water.

Increases capillary attraction.

100 lbs. sand	will hold 25 lbs. of water	} Power to hold water in- creases with fineness.
100 „ loam	„ 40 „ „	
100 „ clay loam	„ 50 „ „	
100 „ clay	„ 70 „ „	

Power to absorb atmospheric moisture likewise increases.

1,000 lbs. of sand in 12 hours at night gained 2 lbs.

1,000 „ loam „ „ 21 „

1,000 „ clay loam „ „ 25 „

1,000 „ clay „ „ 37 „

Connection between the possession of these powers and the rental value:—

1,000 lbs. Bagshot sand, worth 4s. or 5s. per acre, absorbed 3 lbs. of water.

1,000 lbs. coarse sand, worth 15s. per acre, absorbed 8 lbs. of water.

1,000 lbs. sandy soil, worth 28s. per acre, absorbed 11 lbs. of water.

1,000 lbs. Essex, worth 45s. per acre, absorbed 13 lbs. of water.

1,000 lbs. Somerset fertile soil absorbed 16 lbs. of water.

1,000 East Lothian, very fertile, absorbed 18 lbs. of water.

The mechanical structure is the cause of the fertility.

Mechanical Condition, Farmer's duties in—

To enable plants to search for food.

To secure presence of plant food materials.

Materials to be in available form for plants.

Soil to be favourable for the food to be utilised.

To understand the natural character of the land.

To show tact and skill in regulating conditions.

To have familiar acquaintance with temper, disposition, and character of soil.

To know the soil's chemical constituents.

To rightly use scientific knowledge.

Seed-bed.

1. Conditions vary ; requirements constant.

2. Regular admission of moisture to the seed.

3. Use clean seed to favour the utility of the seed's irrigating channels.

4. Regulate the time of sowing.

5. Seed sown at proper depth. The finer the seed the nearer the surface of the ground.

6. Give roots plenty of deep soil ; increase their feeding space. Has great effect on barley, which is usually a sensitive plant.

7. Never have a plough-pan.

8. Neglect of thorough tillage is a loss of the cost of manure used.

9. Allow the air to have a free passage through the soil.

Adopt autumn ploughing.

1. Deepens the staple of the soil and increases its quantity.

2. Brings sour land to the surface, and exposes it to wind, rain, and frost.

3. Renders it sweet.

4. Changes its colour.

5. Secures raw material to convert into meat or corn.

6. Moves the subsoil.

7. Allows drains to draw water and air through them.

8. Gives increase of capital without extra rent or taxes.

Spade Industry.

1. Work is thoroughly complete.

2. More effective cultivation.
3. Work is deeper.
4. Division of soil more perfect.
5. Larger command of feeding space.
6. Increases the supply of plant food.
7. Offers an easier search for it.
8. Yields a largely increased production.

Steam Cultivation should be at proper depth in autumn, then in spring in suitable weather, and thoroughly scarified. Then it—

1. Gives the land the thorough working of the spade.
2. Stirs the subsoil.
3. Gains time at rate of 400 per cent. above horse.
4. Improves crops in bad seasons.
5. Land is well underdrained.
6. Ordinary drains assisted.
7. Produce materially improved.
8. Improves condition of subsoil.
9. Cleans the land more thoroughly.
10. Eventually renders management more economical and satisfactory.

Mechanical Condition.

1. Exerts its influence throughout the plant's life.
2. Most powerful during germination.
3. *Freedom* for extension and firmness for support necessary.
4. Use proper crops as forerunners for others.
5. Clover or rape
Turnips or potatoes } Before wheat.
6. Influenced by tillage operations.
7. Treacherous soils sown immediately after furrow plough, then rolled in.
8. To look upon chemical composition as indicative of productive powers is a fatal error.
9. To be considered before sowing turnips—
 - (a) *Method.* If sown in damp, and followed by drought, the plant will die off or be eaten by the bug-fly.
 - (b) *Method.* Land encouraged to be thoroughly fine. Seed then sown at heavy showers will rush into rough leaf.
10. Open soil disadvantageous to French clover ; give it a hard and firm seed-bed.

Plant Growth.

1. Plants only grow by making use of the food they receive.
2. Plants have equal necessity for food as animals.
3. Plant food imperceptible.
4. *Its materials* discovered by chemical analysis.

5. Regularity in the substances used, viz. :—

(a) **Organic** gas thrown out when burnt—

Oxygen	.	.	.	.	O.
Nitrogen	.	.	.	.	N.
Hydrogen	.	.	.	.	H.
Carbon	.	.	.	.	C.

(b) **Inorganic** ash left when burnt—

Silica	.	.	.	.	SiO ₂ .
Phosphoric Acid	.	.	.	.	H ₃ PO ₄ .
Sulphuric Acid	.	.	.	.	H ₂ SO ₄ .
Carbonic Acid	.	.	.	.	CO ₂ .
Chlorine	.	.	.	.	Cl.
Lime	.	.	.	.	CaCO ₃ .
Potash	.	.	.	.	K ₂ CO ₃ .
Soda	.	.	.	.	Na ₂ CO ₃ .
Magnesia	.	.	.	.	MgO.
Iron Oxides	.	.	.	.	FeO.

Plant Food.—To prepare specimen artificially, take a wide-mouth bottle of one or two quart size. Plant at mouth supported by a cut cork. Darkness within to be secured, prevent green fungoid.

Materials.—300 grains fine bone dust.

Half a pint of water.

Nitric acid cautiously added to dissolve bone dust.

Flask gently heated.

Solution of potassium carbonate, K₂CO₃, added till liquid becomes turbid.

170 grains potassium nitrate, KNO₃.

107 grains sulphate magnesia, MgSO₄.

46 grains potassium chloride, KCl.

One drop perchloride of iron, FeCl₃.

All concentrated in one quart. Two table-spoonfuls to one quart of distilled water. The iron necessary to give the green and healthy tone to the yellow and sickly plant. Distilled water necessary for experiments, as spring waters are so charged with substances they pass through, and rain water impregnated with atmospheric matter.

1. Plants take in their mineral food in a very dilute condition.

2. Food of a bright and clear form.

3. Show want of all materials by—

(a) Sickly and enfeebled appearance.

(b) Cessation of growth.

(c) Death.

4. All substances should be constantly present.

5. Many are absolutely necessary.

6. A complete supply is indispensable.

Preparation.

1. Soil purifies and deodorises offensive matter.
2. The double silicates are the most powerful agents.
3. A complete purification of decaying manure.
4. The constituents of the soil arrest the products of decomposition when set free.

Method of Feeding.

1. Feeds by roots—
 - (a) Through the fine hairs, which filter and purify the food supplied.
 - (b) Drinks in the mineral matters with nitrogen, carbon, hydrogen, and oxygen.
2. Fed by leaves, by their stomata on the under sides; breathes in carbonic acid (CO_2).
 Throws out O when in light of day.
 Breathes in other gaseous substances.
 Throws out moisture.
 Roots and leaves guard the entrance from injurious food by closing their openings.
 The order of importance of inorganic food in—

Wheat	Beans	Turnips	Clover
Silica	Potash	Potash	Lime
Potash	Lime	Lime	Potash
Phosphoric Acid	Phosphoric Acid	Sulphuric Acid	Magnesia
Magnesia	Magnesia	Phosphoric Acid	Phosphoric Acid
Lime	Silica	Salt	Sulphuric Acid
Sulphuric Acid	Soda	Carbonic Acid	Silica
Soda	Salt	Soda	Salt
Iron	Sulphuric Acid	Magnesia	Soda
Salt	Iron	Silica	Iron
		Iron	
Barley	Oats	Potatoes	Grass
Silica	Potash	Potash	Silica
Phosphoric Acid	Phosphoric Acid	Sulphuric Acid	Potash
Lime	Silica	Phosphoric Acid	Lime
Magnesia	Sulphuric Acid	Magnesia	Soda
Soda	Lime	Chlorine	Sulphuric Acid
Iron	Magnesia	Silica	Magnesia
Alumina	Iron	Lime	Phosphoric Acid
Sulphuric Acid	Salt	Soda	Chlorine
Chlorine		Iron	Iron

Fertility of Soil.

1. Shown by successful growth of crops suitable for climate.

2. Requirements.

1. Necessary supply of plant food.
2. Good tillage operations.
3. Favourable conditions of climate.
3. If not present the produce will be limited by their deficiency.
4. Mineral constituents in the ash of the plant show minimum requirements.
5. No definite guidance on organic constituents of carbon, hydrogen, and oxygen; plentiful supply in air and water, but supply of nitrogen requires the greatest care of the cultivator.

Inorganic Matter in Crops.

	WHEAT		BEANS		TURNIPS		CLOVER
	Corn 25 bush. 3,000 lbs.	Straw	Corn 25 bush. 2,800 lbs.	Straw	Bulbs 20 tons	Tops 6 tons	Hay 2 tons
Potash, K_2CO_3 . . .	7.49	18.21	22.63	89.17	125.73	75.95	52.00
Soda, Na_2CO_3 . . .	.97	.90	6.68	2.69	22.98	16.23	7.00
Magnesia, MgO . . .	3.07	4.11	5.03	11.24	12.27	9.27	35.00
Lime, $CaCO_3$. . .	.85	9.34	3.63	33.58	37.87	69.81	111.00
Phosphoric Acid, H_3PO_4 .	11.47	8.15	23.67	12.16	31.11	27.87	20.00
Sulphuric Acid, H_2SO_4 .	.08	5.82	.61	1.83	42.26	36.56	13.00
Silica, SiO_2 . . .	.84	101.82	.72	11.84	11.66	2.58	10.00
Peroxide of Iron, Fe_2O_3 .	.20	1.32	.35	—	3.71	2.58	3.00
Common Salt, $NaCl$. .	.03	.33	.90	7.15	28.69	38.15	8.00
Carbonic Acid, CO_2 . .	—	—	—	—	21.71	21.00	—
	25.00	300.00	63.00	168.00	340.00	300.00	259.00

Each and all the bodies required for luxuriant growth. Substitution of one kind of plant food for another involves an unnecessary risk, and without all the elements the plant will die. (Vide Jamieson's 'Experiments'.)

Laws.

1. That portion of food least abundant determines fertility of soil.
2. No use supplying that which does not fill the deficiency.
3. Fertile soils contain all the plant requires.
4. In moderately productive soils plant food is not in sufficient abundance.
5. Fertility injured by presence of injurious matter.
6. Fertility injured by imperfect tillage or bad climate.
7. Failure in growth of paying crops arises from partial exhaustion or deficiency.
8. Supply the required amount of nitrogen, an element more necessary than any.

9. Methods of supply.

- (1.) By ammonia from atmosphere.
- (2.) Accumulation of vegetable matter in the soil.
- (3.) By good farmyard manure.
- (4.) By nitrogenous manures.

Methods of Feeding or Preparing Food.

1. All solid food must become dissolved in water.
2. Soluble portion of soil alone able to act as plant food.
3. Large portions of matter not acted on by CO_2 is in reserve.
4. What is in the soil is ready to be used as plant food.
5. Useful analysis distinguishes between active and dormant matter.
6. $\text{O} : \text{CO}_2$, frost, H_2O , prepare dormant for activity.
7. These elements arrested by double silicates and kept in safety till required.
8. $\text{CaO} + \text{H}_2\text{O}$ another agency (quicklime).

Alumina.

1. Present in the soil but not in plant food.
2. Double silicates are (1) silicate of alumina, and (2) (a) lime, (b) or of potash, (c) or of soda, (d) or of ammonia.
3. Order of compounds, H_3N , K_2CO_3 , CaCO_3 , Na_2CO_3 . The higher favourite puts out a lower and unites with the silicate of alumina.
4. The powers of vegetable life command an influence over each and all the second rank partners.
5. Performs work of outdoor servant.
6. Reconstructs broken-up partnerships.
7. Amidst the faithless constant only she.
8. Acts as purveyor of food for the plant.

Ferrous Oxide. Protoxide of iron, FeO .

1. Unfavourable to vegetable growth.
2. Presence shown largely in yellow clays.

Tests.

Magnetic.

Readily absorbs O.

With caustic alkalies forms a white precipitate.

With yellow prussiate of potash, light blue precipitate.

Ferric Oxide. Peroxide of iron, Fe_2O_3 .

1. Valuable in promoting vegetation.
2. When exposed, absorbs H_3N from the air.
3. When buried, gives its H_3N to the growing crop.
4. In case of necessity gives up portion of its O and re-takes form of FeO .
5. Yellow clay ploughed in autumn changes into Fe_2O_3 .

Tests.

Non-magnetic.

Does not absorb O.

With caustic alkalis forms reddish-brown precipitate.

With yellow prussiate of potash a deep blue precipitate.

Hence the importance of autumn ploughing.

Organic Acid.

1. Formed by vegetable decay in absence of O.

2. Unfit for nutrition of plants.

3. Corrected by (1) exposure to O of the atmosphere;
(2) drainage.*Demands by Various Crops.*

—	—	ONE ACRE OF		
		Turnips	Wheat	Clover
Potash	K_2CO_3	201 lbs.	25 lbs.	52 lbs.
Phosphoric Acid	H_3PO_4	59 "	19 "	20 "
Sulphuric Acid	H_2SO_4	79 "	6 "	13 "
Chlorine	Cl	66 "	0.5 "	—
Lime	$CaCO_3$	107 "	10 "	111 "
Soda	Na_2CO_3	39 "	2 "	7 "

1. By the term 'land exhausted' is meant the food supply for a particular crop is imperfect.
2. Inability to produce one crop may be capability for another.
3. Necessary material least abundant determines fertility.
4. If the demands of the crop are in advance of the supply exhaustion is result.
5. Always return to the soil the material it needs.
6. Avoid exhausting the soil by making the reserves of fertility useful for plant growth and supply any deficiency by means of manures.

PART II.

SEEDS, CORN, AND DISEASES.

SEEDS.

1. HAVE been greatly improved by various processes.
2. Hence they have higher type of character than their predecessors.
3. Always study to give them permanence of character.
4. The hereditary influence is thus established.
5. Different characteristics are in the individual grains of same wheat-ear.
6. Each seed has a tendency to produce its similar peculiarities.
7. Always select the grains of a desired peculiarity.
8. Result in larger proportion of grains so distinguished.
9. Certain permanency of character is thus established.

Improved by

1. New varieties produced by blending different growths while plants are in bloom.
2. We commence with plants of a known character.
3. The antecedents of the varieties are thus well known.
4. Important if seed is suitable to the soil and climate.

Sample of Oats on similar Land.

	PRODUCE PER ACRE	
	Good Seed	Very Inferior Seed
Flesh-forming matter . . .	84½ lbs.	12 lbs.
Fat and heat-producing matter	943½ "	295½ "

5. A settled point of character in the selection causes accumulation of energy under various conditions.
6. The hereditary powers of seed are intensified in reproducing its own type and character.

7. Sometimes weak in the powers of reproduction.
8. Selection of seeds should be from strongest plants.

Age of Seed.

1. Influences the growth and development of produce.
2. For example, *new swede* seed is of greater vigour than that one or two years old.
3. New seed is more necky, and disposed to run to seed.
4. New seed has greater rapidity of growth.
5. *Old seed* is of slower progress, but less easily checked.
6. *Old seed* plant preserves its form. Feeding quality improved; of steadier and firmer growth. Less liable to mildew.

Change of Seed.

1. Implies preparation for any soil by its own condition of growth, or change of soil and climate for the seed.
2. Re-sowing many times of the same seed on the same farm decreases in produce yearly.
3. Every farmer should know the requirements of his seed-corn.
4. In seed-corn-growing districts, rarely we find perfect conditions of growth.
5. Change of soil and climate rectifies certain imperfections, as increased vigour of growth and powers of reproduction.
6. Results of local opinions should be preserved, then able to lay down certain principles for guidance.
7. The grower should secure good character and pedigree power.
8. Able to regulate supplies for various soils and districts.

Value altered by Change of Seed.

SUBSTANCE	PRODUCE PER ACRE	
	With change of Seed	Without change
Flesh-forming matter	151½ lbs.	40 lbs.
Fat and heat-producing matter	1,253 „	490½ „
	46 bush. at	24 bush. at
	43 lbs. each	32 lbs. each

Results.

1. Increase of general constitutional strength.
2. Conditions of bodily health and strength improved.
3. A general development of the crop.
4. Establishes perfection of character.
5. Secures a better reward for labour bestowed.

6. Well-bred seeds can overcome certain difficulties of conditions.
7. May be compared to well-bred stock in its results.
8. Much is to be done in improvement of farm seeds.
9. Ability to introduce more or less rapid conditions of growth by growing the seed in a quicker or slower climate.
10. Example—the Swiss oats introduced into Scotland give two weeks' gain of harvest.
11. May give a more hardy character to the seed without loss of feeding power.

Conditions necessary for perfection of seed.

I. Climate.

1. Grower's aim should be to encourage variations in form and character, which temporarily modify the plant's growth.
2. Natural conditions best adapted for preservation of species.
3. Processes produce delicacy of character.
4. If climate be too severe, less perfect development.
5. Cultivation of certain crops are limited to certain districts.
6. Growth interfered with by bad management.

II. Fall of Rain.

1. Exerts controlling power over farmer's proceedings.
2. Greater in the west than eastern districts.
3. Grass and green crops in the west, corn in east.
4. West, the breeding and rearing of cattle and sheep.
5. Consequently influences the mechanical condition of soil.

III. Average Temperature.

1. Influences our selections of crops to be grown with greatest advantage.
2. Wheat and mangel in warmer districts and on strong soils—clays, and clay loams.
3. Oats, turnips, and swedes in colder and damper districts.
4. Barley ranges almost as much as oats. Hardy Bere of the south equals in quality the oats of the north. Finer varieties of oats rival best samples of barley. If oats gain in the north, barley gains in the south.

V. Social Conditions of Climate.

1. Advantageous to cultivate crops suitable to the district.
2. *Limit the variety of crops.*

3. Shows the best means of utilising beneficial influences in the operations.
4. Farm practice dictated by local necessities.
5. And to avoid the impediments peculiar to neighbourhood.
6. To farm successfully, attend to improved local experience.
7. Always respect local customs, and advance prudently.
8. Prevents farm work from being one dull routine of labour.
9. Gives additional opportunities for exercising mental powers.
10. He who disregards local experience cannot be a prudent leader.

CEREALS.**Oat.**

1. One of the most hardy of the corn crops.
2. Suited for high lands and severe climates.
3. Scotch oatmeal is unequalled.

Cultivation.

1. Great variation in produce per acre, weight per bushel, and feeding quality.
2. Not necessary that an equal quantity of food should be in an equal weight of oats.
3. Thoroughness in tillage work.
4. Depth of soil well permeated by the atmospheric air.
5. Seed good and suited to soil and district.
6. A particular variety of seed-oat cannot be equally suitable for all kinds, soils, and climate.
7. Encourage for a time the grassy growth of the young plant by securing a fair proportion of root.
8. If grassy growth continued too long, corn is greatly injured.

Specimens of four crops grown on similar soils :—

A.	Grown on small island,	2 miles from sea,	200 ft. above sea.
B.	„ highland farm,	60 „	1,100 „
C.	„ inland farm,	16 „	300 „
D.	„ inland farm,	30 „	800 „

Produce per acre in each case :—

A.	44 bushels, each 29 lbs.	= 1,276.
B.	32 „ „ 40 „	= 1,280.
C.	42 „ „ 36½ „	= 1,533.
D.	48 „ „ 38 „	= 1,824.

9. Do not say proximity to sea always decreases weight per bushel.
10. In 1877 were grown 80 bushels of 40 lbs. each close to sea.

11. That which encourages continued grassy growth gives light corn.
12. *Straw*.—That which gives poor corn gives over-abundant straw, but of inferior quality.
 - (1) Value not to be overlooked.
 - (2) Differs in value according to district in its chemical composition.

Results.

1. Makes good growth in strong turf.
2. Tough furrow slice is suitable to the oat.
3. The root of the oat has greater penetrating power than that of other cereals.
4. Roots encourage rapid decay.
5. Facilitate subsequent tillage operations.

Influence of Drainage.

1. This crop can withstand difficulties better than others.
2. On wet soils this crop generally less.
3. On drained land one acre produced 1,075½ lbs.
4. On undrained land one acre produced 637½ lbs.
5. Helps the ripening.
6. The albuminoid in oats is fit for use after good harvesting; ripening on the ground and dried by winds and frost in stacks.

Ripening the Oat.

1. Influence of cold in small stacks.
2. Influence of heat in large stacks.

Swiss Oat.

1. Adopted in Scotland with great success.
2. Rapidity of plant's growth is influenced by another climate.
3. Rapid growth is a habit to the plant in Swiss valleys.
4. In Scotland it is two weeks at maturity earlier than other sorts.
5. Should be adopted by other cereals.
6. Good harvest the result.

Improvement.

1. By increasing its pedigree character.
2. Occasional growth in another climate.
3. As oat is improved, oatmeal takes a higher position.

Value as Food.

1. Objected to in hot climates.
2. And by persons taking little exercise.
3. Most valuable food for sustenance in fatigue.
4. Contains high percentage of flesh-forming matter.
5. Greater than wheat by about 50 or 60 per cent.
6. Good oatmeal contains 8 to 10 per cent. of fatty matter.
7. *Crop merits every care and attention to render it more perfect and abundant.*

Wheat.

1. The general flour used for bread.
2. More varieties than of any other grain.
3. Seed differs in—

Form.	}	Produced to fully utilise the peculiarities of climate.
Habits of growth.		
Hardihood of character.		
4. It is imprudent—
 - (a) To sow finely-developed white wheat on cold clay soil.
 - (b) To sow strong, coarse, red wheat on finely-favoured wheat soil.
5. Skill required to modify growth of wheat to obtain—
 - (1) Fineness of character.
 - (2) Proper development in the neighbourhood in which it grows.
 - (3) Two opposing points of character between red and white wheat.

Red. A. (a) Great hardihood of character.
 (b) Seed will stand much rough weather.
 (c) Its produce is coarse in texture, but large in yield per acre.

White. B. (d) Strong in bran and straw, but inferior in flour.
 (a) Very fine and delicate wheat.
 (b) Plant will suffer if exposed to severe cold.
 (c) Needs much sun to bring to perfection.
 (d) Little fine bran, abundance of fine flour.
 (e) Large produce per acre.

Exceptions to the above—

As red wheat may be raised to a fine quality,
 White may be lowered to a coarse quality.

Varieties of Seed Wheat.

1. Aim of cultivator should be to produce wheat of as high a quality as his climate will permit.
2. Imprudently aiming too high is punished by a greater or less failure.
3. If too cautious, an inferior quality than even weeds is result.
4. Guided by general character of previous seasons.
5. So much depends on the weather, like a sailor with set sails nailed to the mast.
6. Advisable to grow a stronger seed in all changeable climates.
7. Choice is often to be made under unknown conditions.
8. Efforts should be for hardy seed of good quality.
9. Varieties have a permanency of character.
10. Hereditary character in farm seeds is important, and should be encouraged.
11. Secure, as in live stock, a hardy character and high quality.

Conditions of Sowing.

1. Requires firm seed-bed, not hard nor tough.
2. Ability for the roots to establish a firm hold in the soil.
3. Roots to penetrate with freedom.
4. The supply of organic matter to be in accordance with the nature of the soil.
5. Good growth of clover excellent preparation for wheat.
6. Secure firmness of root to prevent wheat being thrown out by frost.
7. Introduce more organic matter by improving the mechanical condition of the land, and encourage the growth of clover.

Time of Sowing.

1. Highly-developed wheat is reliable for seed.
2. Some seed to be sown in autumn and some in spring.
3. A reversion would be an alteration in results.
4. By cautious management results may be slightly modified.
5. Wheat when of a certain weight or quality contains all the necessaries for good food.

Harvesting.

1. Certain wheats are liable to loss from corn being shaken out, and the quality is somewhat injured.
2. If cut with a slight greenish colour—
 - (a) The wheat skin ceases to thicken.
 - (b) The bran is much finer.
3. For seed-wheat a natural ripening is preferred.
4. Thicker bran is a greater protection for the seed when it is sown.
5. Allow drying process to continue after stacking.
6. Valuable condition by this is acquired.
7. If not completed, effects are injurious. A compelled mixture of old with new in grinding necessary.

Wheat Straw.

1. Demands farmer's watchful care.
2. Admits of many variations, influenced by—
 - A. *Seed Wheat*, which predisposes to :
 - (a) Long straw.
 - (b) Short straw.
 - (c) Weak straw.
 - (d) Strong straw.
 - (e) White straw.
 - (f) Red straw.
 - B. That which favours corn has but little effect on straw. That which favours grassy growth of straw does not benefit the grain.

Encourage or	}	progress of growth.
Check		
 - C. *Soil may check* a predisposed strong straw.

Continuous Growth of Wheat.

1. For 150 years, more or less, successful in practice.
2. Jethro Tull imagined it possible as vine culture.
Unsuccessful through imperfect tillage and want of manure.
3. Lois Weeden system.
Successful for several years, bringing 34 bushels per acre.
Worked by alternate strips of 2½ feet of wheat and fallow.
Deeper tillage, greater perfection, use of manure.
4. Mr. Prout, of Sawbridgnorth, on farm of 450 acres.
 - (1) Entire produce, corn, hay, and straw, removed from farm.
 - (2) Land thoroughly cultivated by machinery.
 - (3) Well-selected manures used, about 50s. per acre yearly.
 - (4) Land thoroughly well drained.
 - (5) In 1877 one of recent bad harvests.
Crop, 48 bushels, at 62 lbs. per acre.
Fourth crop was of wheat in direct succession.
Ninth corn crop without intervening crop or bare fallow.
5. This system needs thoroughly good tillage and well-selected manures. It also needs strong loam or clay, good reserve of dormant matter, strong and hardy well-bred seed. Supplement a thorough cultivation by judicious use of manures.
6. May strengthen a naturally weak straw.

D. Degree of Ripeness.

1. Greenness in the stalk gradually disappears up to the neck.
2. The ear by degrees assumes the final colour of the red or the white sorts.
3. The corn or grain loses its soft green and milky character, and becomes dry and hard.

Barley.

Three objects in growing it.

A. High Feeding Quality.

Requirements.

1. Well-cultivated and fertile soil.
2. Moderately warm climate.
3. Well-bred seed.
4. Follow good swedes liberally fed on the land.

Dangers.—Excess of rain causes too strong growth of straw. Straw strengthened by applying 2 to 4 cwt. common salt (NaCl); steadier, slower, firmer growth.

B. Good Malting Barley.

1. One of the most remunerative kinds.

2. Good feeding barley is not good malting.
3. Necessary to follow a crop, taking off the rankness of farmyard manure.
4. Best when it follows spring wheat.
5. Is to be developed to an excessively thin and delicate skin.
6. To have an excessive supply of starch.
7. To have a small supply of nitrogenous matter.
8. Impossible to be grown on every soil and in every climate.
9. Needs a free supply of lime and a fine climate.
10. *Condition of Nitrogenous matter present*—
 If imperfectly matured a troublesome fermentation ensues.
 If ripening be perfect the fermentation is gentle.
11. To be thoroughly ripe before cutting.
12. Imperfect ripening easily detected by the maltster.
13. The malting process imitates the germination in the soil.
14. Diastase formed around the stem immediately on growth.
 - (1) Influences the economic use of malt.
 - (2) Is the agent preparing the food for the young germ.
 - (3) A great assistant in producing meat.
 - (4) Turns the insoluble starch in the seeds into soluble sugar.
 - (5) The percentage of starch determines the proportion of sugar.
 - (6) Regulates the quantity of barley in the brew.
 - (7) Its usefulness depends on the abundance of starch.
 - (8) The farmer can produce it from inferior barley.
15. The nitrogenous matter is 10 per cent. of the starch.
16. At this amount it is sufficient and satisfactory in influence.
17. An *excess* objectionable ; a *deficiency* unsatisfactory.
18. Some inferior malting barley has great power to produce diastase.

Barley's Seed-bed.

1. Must be in good condition, light, and well worked.
2. Examples of two beds in same field—
 Good dry, when sown, 40 bushels at 58½ lbs. each.
 Good wet, when sown, 24 bushels at 54 lbs. each.

C. Good Seed Barley.

1. Conditions for malting barley prevent its being hardy enough for seed.
2. Safer to take the tail-barley from a superior sample.
3. Less fully developed grains more fitted for seed.
4. Such tail-barley sown on strong soil in favourable climate.
5. Loses all trace of malting character.
6. Hereditary habit and character not altered or reduced.

7. All evidence of malting barley lost and unobservable.
8. Let a sample of each, (a) ordinary and (b) tail-malting, be sown under favourable conditions.
 - (a) Its produce will be in advance of its own appearance.
 - (b) This will be most unusually prolific.
On strong land acquires great constitutional strength.
Its character lost for a time.
Gained increase of power for producing a great crop.

D. Continuous Growth of Barley.

1. Influence of successive corn beds shown in barley.
2. Produces high quality malting barley.
3. Example on Mr. Prout's farm in bad corn season—
 - (1) The third barley crop after two wheat crops.
 - (2) Yield 50 bushels at 54½ lbs. each per acre.
 - (3) Nearly the heaviest crop of barley in the kingdom.
 - (4) Upon analysis possessed full average feeding powers.
4. Bad harvest weather deteriorates values of barley, seen by following table :—

The harvested crop, 40 bush. at 56 lbs. } loss of 594½ lbs.
 The damaged crop 40 bush. at 40 lbs. } per acre.

Composition of Barley	Good Harvest	Bad Weather
True albuminoid matters (gluten)	6.40	8.30
Starch, gum, &c.	73.97	67.35
Fatty matter	1.10	1.24
Cellulose	2.11	4.66
Nitrogenous matter (not true albuminoids)	1.01	2.27
Containing nitrogen	(.159)	(.36)
Ash	2.45	2.77
Water	12.96	13.41
	100.00	100.00

Steeps for Corn Seed. To prevent its diseases.

1. 1 lb. green vitriol to four bushels. Add sufficient water to cover the grain. Dry it with caustic lime and gypsum.
2. Ferrous sulphate.
3. Arsenic and soda.
4. Slaked lime.
5. Sodium sulphate dried off with caustic lime, gypsum, and caustic soda.

CORN DISEASES.**A. Wheat.****1. Smut** or 'dust brand,' a minute fungus.

- (1) Destroys the ear by decaying the innermost part of the flower.
- (2) The pedicles become swollen and very fleshy.
- (3) The fungus feeds on this fleshy mass.
- (4) Shown by the dark soot-like powder.
- (5) Generally dispersed before corn is cut.

Cure.—Steep seed in CuSO_4 , blue vitriol 1 lb. to 4 bushels, for 20 minutes.

2. Bunt or pepper brand, caused by attacks of *Uredo cares* fungus :

- (1) Confined chiefly to wheat ; attacks grains only.
- (2) Seen in rounded appearance and dark colour of grains.
- (3) When fully ripe fills the interior of the seed.
- (4) Does not rupture the skin.
- (5) Appears to consist of numerous sporules, 4,000,000 in one seed.
- (6) A few diseased ears sufficient to infect large bulk of grain.
- (7) Generally ground up and made into gingerbread.
- (8) Grains have unpleasant odour when crushed.

Cure.—Steep seed in solution of CuSO_4 , and dry by sprinkling CaSO_4 .

3. Rust or red-gum, red-rag, red-robin.

- (1) Seen in yellowish brown or reddish oval spots on the stem, leaves, and chaff.
- (2) No injury if confined to leaves and stem.
- (3) If it attacks delicate wheat on rich soils in the glumes (the ear), it is frequently serious.
- (4) The spores of the fungus are beneath the scarf skin.
- (5) Bursts on arriving at maturity.

4. Mildew—different kinds of fungi.

Its growth and germination same as rust.

Ripe spores are very small, black, club-shaped.

Thicker end divided and filled with sporules.

Effects.—Reduces crop to one-half. The same half much reduced in value.

Cure.—Keep clean waste places and ditches, cutting grain crops low down ; carry out autumn cultivation ; feed crop close down by sheep in spring.

5. Ear-cockle, pepper brand, or purples ; names given by the successive appearances of the ear.

Disease attacks the grain itself.

First stage dark green, then purplish-black.

Husks spread open ; the arms become twisted and curled.

Inside the grain a cotton-like substance, enclosing a number of small eel-shaped twisting animalculæ.

If placed in warm water, seen by the naked eye.

6. Wire Worm.

(1) Offspring of click-beetle.

(2) Oft confounded with the millipede.

(3) Eggs remain in soil, hatch, become wire worms ; five years to get matured.

(4) Eat into stem just above root.

Cure.—Deep winter cultivation, thorough manuring, rolling the seed with heavy toothed roller, plentiful supply of potash salts.

7. Wheat Midge.

Lays its eggs in the wheat flower in early summer evenings.

Eggs hatched become lemon-coloured larvæ ; grain shrivels up.

Then enters the earth and remains till next year.

Check.—Reproduction of its species controlled by *Ichneumon* fly ; latter deposits its eggs in body of former.

8. Hessian Fly.

Fearful scourge to wheat fields of North America.

Wheat cultivation for many years abandoned.

Rarely met with in this country.

Powers of increase kept in check by parasites.

9. Thrips, the most numerous of insect pests.

Attacks wheat and rye in June.

Causes the grain to shrivel up by exhausting its juices.

Attacks late-sown wheat on strong soils.

Cure.—Sow as early as possible.

10. Corn Saw Fly. Small shining black insect.

Abounds in umbelliferous flowers and long grasses.

Young maggot, yellow, wrinkled, dark head.

Is inside the stem, which it consumes.

As the ear is formed the maggot grows and cuts through the node.

Vitality of stem destroyed, maggot descends to bottom of stem ; remains whole winter, changes in spring into fly.

Check.—*Ichneumon* fly hunts and destroys Saw fly.

11. Corn Weevil. Lives in stored grain.

Natives of a warm climate.

Pair in early spring, then female buries herself in heap of grain, depositing one egg in each grain.

Hole runs obliquely or parallel to surface, and closed by excrement.

Maggots hatch ; feed on the interior of the grain.
Full grown in 6 or 8 weeks and ready to propagate.

Cure.—May be discovered by placing grains in water. Attacked grains float. Destroyed by low temperature. Granaries opened and exposed to frosts. Raise malt to 160 degrees ; kill the larvæ.

12. **Grain Moth**, or 'wolf,' from its ravenous appetite.
Abound in summer ; frequent buildings and fields.
Female lays 50 to 60 eggs, one or two in a grain.
Hatched in a few days.

Cure.—Shift the corn, cold air, dry temperature, 80 degrees.

General Rule.

Every plant not producing a cultivated crop is a weed.

Weeds.

Abstract plant food necessary to increase the crop.
Being indigenous and hardy, extract the best share.
Offer a house for perpetuation of fungoid and parasites.
Furnish suitable receptacles for procreative purposes.

B. Barley.

1. **Smut.** See page 24, *Uredo segetum*.

2. **Ergot.** Like mildew.

3. **Wire Worm.**

- (1) Destructive in dry seasons and on cold soils.
(2) The plant attacked changes from dark green to sickly yellow.

Cure.—Not to have a succession of crops requiring same mineral food consecutively on same ground. Same as in wheat.

C. Oats.

1. **Smut.** Very slight in its effects.

2. **Wire Worm.** Owing to oats coming as first crop after old grass lands.

Preventive.—Pare and burn surface before ploughing. Shallow breast-plough about two inches deep. Destroys roots of grasses ; destroys the worms.

D. Rye.

1. **Ergot.**

Influenced by presence of barberry tree.
Organs of plant disturbed at flowering time by atmospheric action.

Due to the presence of minute parasitic fungus ; easily distinguished in the ear.

Effects.—Equally fatal to lower animals as to man. In Germany whole districts have been decimated. Redeeming properties used in medicine.

PART III.

MANURES, NATURAL AND ARTIFICIAL.

MANURES.

Purpose.

1. To refill the imperfect store of plant food.
2. To make good the loss in the soil by the growing crop.

A. Farmyard Manure.

1. When carefully managed, is of great value to the land.
2. Returns to the soil the crop taken off (portion of).
3. The crop is a loan made by the soil, to be repaid partly by manure.
4. Soil prefers its loan returned with interest.
5. The land is not injured by the return of a substituted fertiliser.
6. If all the substances taken by crop be returned, no deficiency.
7. Good farmyard manure contains this variety of substances.
8. Always supply the most needful elements or materials.
9. Good farmyard manure perfectly distributes the mineral matter taken by the crop.
10. A complete series is given punctually without delay.

Preservation of Farmyard Manure.

1. Waste of farmyard manure decreases the repayment of loan received from the land.
2. All farmyard manure drainage is the soluble mineral matters it held.
3. These black streams should be collected in a tank.
4. This liquid pumped on to the heap from time to time.
5. Prevent too excessive rainfall on the heap.
6. The superabundant farmyard manure liquid should irrigate low lands.
7. A certain supply of moisture is necessary for fermentation.
8. Covered manure sheds induce over-heat or fire-fang.
9. Farmyard manure is injured by too much heat, and causes loss of ammonia, H_3N .

10. Ammonia is produced in farmyard manure.

- (a) Combined with decaying vegetable matter, as organic acids.

In this way, if mixed with water is not volatile.

Without water it is changed into CO_2 and H_3N , very volatile, and escapes into atmosphere called carbonate of ammonium, $2(2\text{H}_4\text{NCO}_3)\text{CO}_2$.

11. If air be excluded, fermentation checked.
12. To hasten fermentation, turn it and mix lightly.
13. To check fermentation, compress it as much as possible.
14. Moderate application of liquid manure secures temperate fermentation.

Application of Farmyard Manure.

To clays or stiff loams, fresh and moderately fermented.

Light lands, thoroughly decomposed.

Sandy loams possess little power of retaining soluble matter.

When carrying a rapidly-growing crop, as clover, it should be applied in a thoroughly fermented condition and soft. The ammonia secured in a non-volatile condition. It is quickly absorbed by the growing crop. Most useful method for succeeding wheat crop.

Let farmyard manure be always regarded as part repayment to the soil what the growing crops have taken. Neglect of proper care of farmyard manure is disadvantageous to land and farmer.

Character of Farmyard Manure.

1. Influenced by the food.

Corn and cake produce nitrogenous matter.

Hay and straw, carbonaceous.

2. Age and character of animal.

- (a) Full-grown animal abstracts materials to replace waste.

- (b) Growing impoverishes the food for development of its skeleton, muscles, tissue, &c.

- (c)
- Cattle fully grown*
- , if nourishing calf or giving milk, have a demand for bone, muscle, and tissue. Manure very poor.

- (d)
- Fattening*
- . Full of nitrogen. Cold manure in general; turned often to promote fermentation.

- (e)
- Horses full grown*
- . Food rich in nitrogenous matter. Manure rich in nitrogen; very hot.

- (f)
- Growing horse*
- . Extracts nitrogen and phosphate of lime (
- $\text{Ca}_3\text{P}_2\text{O}_8$
-); manure much poorer.

Most variable in constitution and composition.

Very difficult to analyse.

Well mix the excrement of each class of animal.

The slow checks the rapid, and uniformity produced.

Materials in Farmyard Manure.

Water	H_2O .
Soluble organic matter containing Nitrogen.	
Soluble inorganic matter.	
Silica	SiO_2 .
Phosphate of Lime	$Ca_3P_2O_4$.
Lime	$CaCO_3$.
Magnesia	MgO .
Potash	K_2CO_3 .
Soda	Na_2CO_3 .
Chloride of Sodium	$NaCl$.
Sulphuric Acid	H_2SO_4 .
Carbonic Acid	CO_2 .
Insoluble organic matter containing Nitrogen.	
Insoluble inorganic matter.	

Changes during Fermentation.

	Fresh Manure.	Well-Rotted.
	cwt. qrs. lbs.	cwt. qrs. lbs.
Fertilising substances	0 1 19 $\frac{3}{4}$	0 1 19 $\frac{3}{4}$
Other materials, chiefly organic matter	6 1 10	4 1 27
Water	13 0 26 $\frac{1}{4}$	15 0 9 $\frac{1}{4}$
	20 0 0	20 0 0

In One Ton of Manure.

Fertilising substances, value 8s.	48 lbs.
Water	13 to 15 cwt.
Materials of little market value	4 to 6 cwt.

Influence of Farmyard Manure.

Its mineral matter.

Organic matter in farmyard manure of two classes.

A. Nitrogenous.

1. Encourages decomposition or fermentation.
2. Induces other bodies to take part in 1.
3. Engenders heat and induces straw to take part.
4. Carbonaceous matter in straw assists fermentation.

(a) Shown by change of colour.

5. Change solid substances into organic acids.

(a) Humic acid + H_3N = Humate of ammonia.

(b) Ulmic acid + H_3N = Ulmate of ammonia.

Blackish colour dissolved in the black liquor draining from farmyard manure non-volatile.

6. Unite with H of the moisture and forms H_3N .
7. H_3N secured from loss by uniting with organic acid.

B. Carbonaceous.

All those substances which would burn—straw, litter, &c.

Employment of Farmyard Manure.

1. Time varies according to climate and condition of soil.
2. Power of soil to hold farmyard manure determined by proportion of clay present.
3. Only some bodies associated with clay hold manure.
4. The double silicates a modified form of clay.
5. Seldom higher than 4 to 5 per cent.
6. An increase of double silicates increases power of retention in other soils.
7. If we know the soils which will retain the manure, we are able to use it when it best suits the crop.
8. Difficult on non-retentive soils or light lands.
9. Manure more effective when thoroughly distributed.
10. Most advantageously applied to clovers on light lands.
11. Thus rendering dormant into active soil.
12. Applied to corn crops, brings too much straw and less corn.
13. If given to beans, top the haulm, pods begin to fill.
14. Its use should be largely restricted to green crops, roots, and clover.
15. Well mix that from cattle, pigs, and horses.
16. Great uniformity produced.
17. Early preparation for use secured.

Improvement of Farmyard Manure.

1. Use artificial food and corn.
2. Both meat and manure improved.
3. Value of farmyard manure based on value of feeding stuffs.
4. The market value of manure from each ton of feeding stuff:—

(1) Cotton cake, decorticated (variable prices)	£6 10 0
(2) Rape seed	4 18 6
(3) Linseed cake	4 12 6
(4) Malt dust	4 5 6
(5) Cotton cake, undecorticated	3 18 6
(6) Beans	3 14 0
(7) Linseed	3 13 0
(8) Peas	3 2 6
(9) Bran and pollards	2 18 0
(10) Clover hay	2 5 6
(11) Oats	1 15 0
(12) Wheat	1 13 0
(13) Malt	1 11 6
(14) Indian meal	1 11 0

(15) Meadow hay . . .	(variable prices)	£1 10 6
(16) Barley . . .	„ „	1 10 0
(17) Locust bean . . .	„ „	1 2 6
(18) Bean straw . . .	„ „	1 0 6
(19) Pea straw . . .	„ „	0 18 9
(20) Oat straw . . .	„ „	0 13 6
(21) Wheat straw . . .	„ „	0 12 6
(22) Barley straw . . .	„ „	0 10 9
(23) Potatoes . . .	„ „	0 7 0
(24) Mangel wurzel . . .	„ „	0 5 3
(25) Swedish turnips . . .	„ „	0 4 3
(26) Turnips and carrots . . .	„ „	0 4 0

5. These items show the importance of care and judgment in managing farmyard manure.
 6. Prevent every kind of waste.
 7. Heap should have an impervious bottom.
 8. Thoroughly pressed to prevent too rapid a fermentation.
 9. Fix H_3N by scattering half cwt. kainit to each ton of farmyard manure.
 10. Cheap method of obtaining K_2CO_3 in effective condition. $Kainit = H_2SO_4 + K_2CO_3 + H_3N = KNO_3 + KCO_3 + (2NH_4)SO_4$.
- Kainit = H_2SO_4 + Potash, uniting with H_3N of the farmyard manure, forms nitrate and carbonate of potash. H_2SO_4 unite with H_3N , and fix the volatile part.

B. Fold Manures.

1. Excrement dropped on the land should be thoroughly distributed.
2. If not, rank grass the result : avoided by cattle.
3. Sweetened by frosty weather.
4. Adopted for proper consumption of root crops.
5. Equally distributes manure.
6. Sheep lairs bring vigorous growth of straw.
7. Shelter and dryness conduce to lairs.
8. Encourage lairs by shelter-giving hurdles.
9. On clayey soils, folds should be large to prevent treading.
10. Encourage warmth of body to prevent waste of food.
11. Increases, in case of clover, the quantity of manure, if parts of field be folded in rotation.
12. Encourages growth of clover and organic matter.
13. The higher the productive power, the larger amount of stock.
14. Differ in composition according to the character of food.

Box System.

1. Excavation 6 inches below the ground.
2. Water-tight bottom and sides.
3. Litter freely supplied.

4. No separation of solid and liquid portions.
5. Accumulation, when removed, excellent in condition.

Stall System.

1. Solid and liquid particles soon separate.
2. Special care required to prevent loss during storage and fermentation.

Fowls and Pigeons' Manure.

1. Most powerful of known manures.
2. Soluble consists of urate, sulphate, and carbonate of ammonia ($C_5H_4H_4O_3$).
3. Insoluble consists of calcium phosphate and magnesium phosphate, (Ca_3PO_4) and (Mg_2PO_4).
4. If moistened, loses ammonia (H_3N).
5. Should be mixed with dry earth or sawdust as a compost.
6. Soluble matter—

23	per cent.	of ammonia	in recent dropping.
16	„	„	6 months old.
8	„	„	old.

Composition of English—

Water, 6.65

Nitrogen, 3.27	} = Organic matter .	59.68	} = 100
Ammonia, 3.96			
Ammonia . . .		1.50	
Alkaline salts . .		.42	
Calcium phosphate	{	7.96	
Magnesium „			
Lime . . .		2.37	
Sand . . .		21.42	

Composition of Egyptian—

Soluble, 23.9.

Insoluble, 76.1.

C. Green Manures.

1. *Definition.*—Growing a crop to plough it into the land.

Advantages.

1. Bring up plant food formerly out of reach.
2. Plant food in more complete form.
3. Plant food presented in a gradually progressive manner.
4. As decomposition increases, the contained inorganic matter is released to enter into new vegetable growth.
5. Solvent powers of CO_2 and organic acids formed increase quantity of plant food.
6. Addition of organic matter to the soil.
7. Increase of valuable nitrogenous and carbonaceous matter.

Classes of Soil improved.**A. Thin, poor soils.**

1. *By mustard, buckwheat, rape, lupin, and borage.*

2. Soil enabled to hold moisture and gaseous moisture.
3. Gradually enriched.
4. The want of inorganic matter not improved.

B. Heavy clays.

1. Soils rendered less sticky and adhesive.
2. Promotes its fertility and productiveness.

I. Character of Green Manures.

Requirements.

1. Should have powers of quick growth.
2. Be deep-rooted to draw up fertilising matter from ordinary depth.
3. Hardy and vigorous in habits of growth.
4. Large leaves and large extent of leaf to draw from the atmosphere.

II. Clover and its Advantages.

1. Grows above ground and beneath the surface.
2. To encourage growth of root, let it stand for mowing.
3. Root improved in its second year by early sheep stinting in first year, or early after-mowing.
4. Rich in nitrogenous matter; land gains more by its growth than by manure added to surface.
5. Gives firmness to the soils of light lands.
6. Gives open character to heavy clay soil.

III. By Sheep Feeding on the Green Manures—

1. Sheep take both organic and mineral ingredients for their bodies.
2. Soil has not received the same matter.
3. Mechanical influence of the vegetable altered.
4. Heavy clays lose the opening influence of the green manure.

IV. Seaweed.

1. Its use is limited to seaside districts.
2. Employed with great success.
3. Eighty tons per acre immediately ploughed in.

V. Fern.

1. In its native districts used with great success.
2. Cut and used whilst still green.
3. Encourages rapid growth of turnips, and strengthens them.

D. LIME, CaCO_3 .

1. A natural fertiliser.
2. Encourages growth of corn of high feeding character.

I. Quicklime, CaO —caustic lime.

1. Preparation.

1. From limestone rock or chalk.
2. Burnt in kilns with coal.

3. Unburnt lime and coal at top; lime drawn out at the bottom.
4. Separation of CO_2 from CaCO_3 .
5. Desires water; with H_2O great heat is shown.
6. Covered up to protect it from further change.
7. Spread over the land, immediately harrowed in.
8. Sets to work without waste.
9. Not to be too deeply harrowed.
10. Works itself to a deeper level.

2. *Action.*

1. Very powerful; seeks reunion with CO_2 .
2. Renders decomposition of organic matter very rapid.
3. Combines with organic acids, and neutralises them.
4. Structural character of organic matter disappears.
5. Lime loses its caustic character.
6. Chemical compounds of lime formed.
7. Stimulates inertness of organic soils.
8. Soluble in water; enters into plant food.
9. Alters and ameliorates subsoil.
10. Awakens the nitrogen of decaying vegetable matter.
11. Unites with N of vegetable matter; heated by CaCO_3 becomes H_3N .
12. Sets H_3N free when in combination with acid matter, and forms HNO_3 , NH_4NO_3 , KNO_3 .
13. Changes dormant into active soil.
14. The alkalis K_2CO_3 and Na_2CO_3 released from the minute rocky particles, and rendered for plant food.
15. Liberates inorganic matter in the soil.
16. Assists in forming *double silicates*.
 SiAl take H_3N , K_2CO_3 , CaCO_3 , or Na_2CO_3
As silicate of alumina and ammonia,

"	"	"	potash,
"	"	"	lime,
"	"	"	soda.
17. Makes double lime silicate on clay.
18. Makes nitrate of potash, KNO_3 .

Formerly obtained from wood ashes.

Old **Commercial Method** of making KNO_3 :— CaO is added to well-manured land, then turned over, and KNO_3 is formed within and afterwards separated by washing. **CHANGES.** Nitrogenous matter is decomposed, and forms NH_4NO_3 or HNO_3 . The potash released from soil unites and forms $\text{K}_2\text{CO}_3 + 2\text{HNO}_3 = 2\text{K}_2\text{NO}_3 + \text{H}_2\text{O} + \text{CO}_2$.

This occurs in farm practice as—

- (1) Formation of compost heaps of earth, vegetables, and lime.
- (2) In farmyard manure on land during time of liming and when ploughed in.
- (3) CaO spread over land and harrowed in.

- (4) KNO_3 formed under the surface.
- (5) Discontinued on account of expense in favour of—
 - (a) Smaller outlays.
 - (b) Quicker returns.
 - (c) Artificial manures.

19. Its mechanical influence on clays is to make them lighter to work.

II. Carbonate of Lime, CaCO_3 , unburnt.

- 1. Prepares other substances to become plant food.
- 2. Dissolves in water containing CO_2 .
- 3. When used as plant food, unnecessary to be burnt.

III. Chalk.

- 1. Able to do much of the work of CO_2 .
- 2. More gradually neutralises the organic acids.
- 3. Slowly assists in decomposing organic matter.
- 4. Used with greater safety than CaO .
- 5. Quickly blends with heavy clays, and mixes with them.
- 6. Should be ploughed in in winter when full of water, and scattered on lands.
- 7. Is pulverised by the frost.
- 8. If not done in early winter much trouble is the result.
- 9. All chalks are not of equal value.

IV. Marl.

- 1. Differs from chalk in the variable quantity of CaCO_3 .
- 2. No similar certainty as to its composition.
- 3. Phosphoric acid and potash found in green manures.
- 4. These two are soluble in weak acids.
- 5. Contains a large percentage of soluble silica.

Effects of Marl.

- 1. Makes sand more tenacious.
- 2. Gives greater power to hold manure.

V. Shell Sand.

- 1. Accumulations on shores of Cornwall, Devon, and West of Scotland.
- 2. Chiefly carbonate of lime with animal matter.

Application of Lime.

I. Time.

- 1. As long as possible before sowing the crop.
- 2. On grass fields before breaking up.
- 3. At far-distant periods from fermenting manure.
- 4. With recent animal matter in a compost.
- 5. Only on land rich in vegetable matter.
- 6. In the autumn, before spring-turnip sowing.

II. Effects on the Land.

- 1. Renders clays open and light.
- 2. Increases fertility of all soils.

3. Adds to the productiveness of moist and inert soils.
4. Produces crops of superior quality.
5. Luxuriant crops from some clays.
6. Brings dormant soil into activity.
7. Increases its value for agriculture.
8. It sets up decomposition in organic soils.
9. Purifies rough and sour pastures.
9. More rapid decomposition of organic substances.
10. Causes organic matter to disappear eventually from plant food.
11. Promotes conversion of H_3N into HNO_3 .

III. Effects on Animal Life.

1. CaO fatal to worms, slugs, and destroys eggs and larvæ.
2. Kills insects attacking corn ; prevents smut in wheat.
3. Prevents foot-rot where gate steads are laid with it, and kills roots of weeds and noxious seeds.

IV. Effects on Productions of Soil.

1. Kills plants natural to silicious and moist soils.
2. Extirpates corn marigold.
3. Encourages red poppy, yellow cow wheat, yellow rattle, and coltsfoot.
4. Kills heath, moss, sour and bent grasses.
5. Improves the soil for the growth of every cultivated crop on sour or inert lands—
 - (1) *Corn*. Thinner skin ; less straw ; more seldom laid ; greater improvement in spring- than in winter-sown wheat.
 - (2) *Potatoes*. Better to taste and more mealy.
 - (3) *Turnips*. Improved in quantity and quality.
 - (4) *Peas*. Improved in taste ; boil soft.
 - (5) *Rape*. Half lime and manure : extraordinary crops.
 - (6) *Flax*. Injurious to strength and fibre.
6. Hastens maturity of crop by 10 to 14 days.
7. Salubrifies the well-cultivated districts.
8. Remedy for finger-and-toe in turnips if limed in the autumn.

V. Effects of Over-liming.

1. If already saturated, produces no good effect.
2. On exhausted and poor lands, no good effect.
3. Farmyard manure with lime does not produce same good results.
4. If vegetable matter be wanting, the seed sown is singed or burnt.
5. Land sometimes hardened as to be impervious to water, and a regular lime pan is formed in.
6. Undrained lands become too hard for cultivation.
7. *Loosens* some soils so as to be incapable of holding water.

8. On No. 7 oats and clover an unprofitable crop.

9. Land thoroughly exhausted—

- (1) The liberated mineral substances very easily removed.
- (2) As lime (CaCO_3) liberates potash (K_2CO_3), Sodium (Na_2CO_3), phosphoric acid (H_3PO_4), Magnesia (MgO), silica (SiO_2).
- (3) The alkaline matter from the rocks is diminished.
- (4) More matter of every kind taken by the larger crops.
- (5) Production and removal of larger crop in a given time.
- (6) Increases the amount of soluble matter set free.

VI. Remedy for Exhaustion.

The use of lime without manure will make both farm and farmer poor.

Return the alkaline matter taken away, such as salt, &c.

Composition of Marls.

	GREEN MARL		GREY MARL		CHALK MARL	
	Soluble	Insoluble	Soluble	Insoluble	Soluble	Insoluble
	In Dilute Acid					
Silica	31·88	22·06	2·16	16·68	2·11	5·42
Carbonic Acid	trace	—	29·96	—	36·73	—
Sulphuric Acid	·45	—	·21	—	·06	—
Phosphoric Acid	3·76	—	·21	—	·05	—
Chlorine	trace	—	·08	—	·04	—
Lime	5·61	1·52	41·52	1·71	49·16	·22
Magnesia	·85	1·09	·30	trace	1·18	trace
Potash	3·21	·45	·26	·32	·11	·15
Soda	1·20	·31	1·64	·07	1·36	·05
Oxide of Iron	16·91	} 5·75	2·20	} 2·57	1·74	} 1·42
Alumina	·74		·11		·20	
Water and Loss. . . .	4·21	—	—	—	—	—
	68·82	31·18	78·65	21·35	92·74	7·26
	100		100		100	

E. Artificial Manures.

I. Peruvian Guano.

1. Introduced in 1839.
2. Contains, when pure, 17 per cent. of H_3N (ammonia) and 20 to 30 per cent. of P_2O_4 (phosphoric oxide).
3. Excrement of birds, accumulation of centuries.
4. An ammoniacal manure.
 - (1) Phosphatic ingredient exerts secondary influence.
 - (2) The H_3N contained less active than H_3N preparations, as ammonium sulphate (2NH_4) SO_4 .
 - (3) Phosphates had been changed from insoluble bone earth into a soluble form.

5. Its influence on strong clays unequalled by any manure excepting nitrate of soda and sulphate of ammonia.
6. Limited by cash payments as to its salt.

II. *Bones.*

1. Used more or less broken previous to guano.
2. Very slow in its operation in this form.
3. The smaller the size, the more rapid the returns.

Ingredients.

Phosphate of lime = phosphoric acid + lime.

Three Compounds of these Two Bodies.

I. Composition of Tricalcic Phosphate	II. Composition of Bicalcic Phosphate	III. Composition of Monocalcic Phosphate
Phosphoric Acid Lime Lime Lime	Phosphoric Acid Lime Lime Water	Phosphoric Acid Lime Water Water
Tricalcic Phosphate	Reagents employed	Products of decomposition
II. { Phosphoric Acid Lime } Lime	Water Carbonic Acid	Bicalcic Phosphate Carbonate of Lime
III. { Phosphoric Acid } Lime Lime	Water Sulphuric Acid	Monocalcic Phosphate Sulphate of Lime

Reduction.

1. *Tricalcic phosphate* = phosphoric acid + 3 lime = $\text{Ca}_3\text{P}_2\text{O}_8$.
 - (a) One equivalent of CaCO_3 removed by CO_2 in the rain.
 - (b) Becomes bicalcic phosphate and CaCO_3 .
Bicalcic phosphate dissolves slowly in H_2O for plant food.
2. *Bicalcic phosphate* the result of water on bone = $\text{Ca}_2\text{H}_2\text{P}_2\text{O}_8$.
3. *Monocalcic phosphate* = $\text{CaH}_4\text{P}_2\text{O}_8$.
 - (1) Rapidly soluble in water.
 - (2) Two equivalents of lime removed by H_2SO_4 and formed sulphate of lime.
 - (3) The three equivalents of lime concentrated into one.
 - (4) This one overdosed with phosphoric acid.
 - (5) Hence the term superphosphate = $\text{CaH}_4\text{P}_2\text{O}_8$.

III. *Gypsum*, CaSO_4 .

Applied at 2 to 10 cwt. per acre to clover and other leguminous crops. Fixes H_3N in farmyard manure by scattering it on stable floors and manure heaps.

1. An inseparable constituent of all superphosphates.
2. Five cwt. of superphosphate involves 2 cwt. of gypsum.

IV. *Coprolites*.

1. Rocks or mineral phosphate of lime.
2. Supplied from Spain, Portugal, Germany, West Indies, United States, and Cambridgeshire.
3. Becomes less in percentage of phosphate by keeping.
 - (1) Farmers prefer that stored for six or eight months to that newly made.
 - (2) These known by *reduced superphosphates* from 25 to 22 per cent. soluble.
 - (3) This done by admixture of 50 per cent. of bone meal.
 - (4) *Standard of valuation* percentage of soluble phosphate.
 - (5) Unit system generally 4s. per unit per ton.

V. *Potash salts* in form of K_2CO_3 , K_2SO_4 , KCl , KSi , all employed with success; occurs in ashes of cultivated plants. Generally sufficient in most soils; abundant in potatoes, hops, clovers, beans, and several leguminous plants.

Kainit found in immense quantities at Strassfurt, Prussia.

Analysis—

Moisture	3·36
Water of combination	10·88
K_2SO_4	24·43
CaSO_4	2·72
MgSO_4	13·22
MgCl	14·33
NaCl	30·35
Insoluble silicones	·71

Reduced Phosphates from Bone.

1. Two months after manufacture reduced in strength.
2. Super: which contained 25 reduced to 22 or 20 per cent.
3. Of greater value to the land.
4. The mono: in the super: is partly changed into bicalcic.
5. It is an increase in value of manure.
6. More lasting in their action.
7. Artificially produced by admixture of finely pulverised bone.
8. Saving to the manufacturers £200,000 per annum.
9. Saving to the consumer, £1,000,000 per annum.
10. Experiment of Mr. Thursfield Barrow—
 - (1) Had for several years found its decided advantage.
 - (2) Added 1 ton $\frac{1}{4}$ -inch bones to 2 tons of super:
 - (3) Bones moderately moistened and mixed with super:
 - (4) Great heat evolved in a few days.

- (5) After five or six weeks manure ready for use.
- (6) Improved as a manure, spoilt for analysis.
- (7) Twenty-seven shillings spent in this equalled in crop 45s. spent in manure of high quality.

Phosphates are of different kinds—

A. Calcium	$\text{Ca}_3\text{2PO}_4$.
B. Potassium	K_3PO_4 .
C. Sodium	Na_3PO_4 .
D. Magnesium	$\text{Mg}_3\text{2PO}_4$.

A. Calcium Phosphate—

1. Found largely in bones of animals.
2. Widely distributed in mineral phosphate and phosphorite.
3. In small quantities in all fertile soils.
4. Abundant constituent of the ash of cultivated plants.
5. Largely drawn upon by oats, barley, and wheat.
6. Its application to land expects excellent results.

Bones—

1. Applied to pastures and turnips.
2. Ground formerly to $\frac{1}{2}$ -inch or $\frac{1}{4}$ -inch in size.
3. Land greatly increased in annual value by their application.
4. Its deficiency in the land caused by the demands of the crops.
5. Young stock decrease its amount far more than fully grown animals.
6. Annual drain by the former, about 8·3 lbs. per acre.

Analysis—

Water	H_2O	6·20
Organic matter		39·13
Ammonia	H_4N	4·8
Calcium Phosphate	$\text{Ca}_3\text{2PO}_4$	48·15
Lime	CaCO_3	2·57
Magnesia	MgO	·30
Sulphur Teroxide	SO_3	2·55
Silica	SiO_2	·30

7. Action of bones accelerated by changing into superphosphate of lime.
8. Mineral phosphates on certain land answer better than dissolved bones.
9. Coprolites found in Cambridge, Suffolk, Norfolk, Bedford, Buckingham.
 - (1) Nodules similar in shape, but inferior in quality, found in France near Boulogne, Rhone Valley, Ardennes.
 - (2) In Koursk, in Russia ; immense beds.
 - (3) Believed to be the fossil and dung of extinct animals.
 - (4) Brown, dark green, or greenish black.

- (5) Various phosphates fossils of extinct organisms—
 (a) Terebratula, belemnites, ammonites, and echinodermata.
 (b) All abound in phosphoric pentoxide (P_2O_5), lime ($CaCO_3$), ferric oxide (Fe_2O_3), alumina (Al_2O_3), carbon dioxide (CO_2).
 (6) Analysis of English coprolites—

Moisture	H_2O	.	.	.	.	.	2·30
Water of combination	H_2O	.	.	.	.	.	1·50
Phosphorous Pentoxide	P_2O_5	{	Tricalcic phosphate of lime.	}	.	.	26·05
Lime	$CaCO_3$				.	.	43·68
Ferric Oxide {	Fe_2O_3	{	}	}	.	.	18·70
Alumina „ {	Al_2O_3				.	.	
Insoluble silicious matter	SiO_2	.	.	.	.	.	7·77

10. **Welsh Silurian Phosphate.**

- (1) Found in lead-bearing clay-slate of Slangynag.
- (2) From 8 to 9 feet thick phosphatic limestone.
- (3) From 1 to 2 feet thick black shale.
- (4) Quality variable.

11. **Canadian Phosphate.**

- (1) Found in granitic fissures.
- (2) Occurs in prismatic six-sided crystals.
- (3) Light green glass-like lustre, brittle texture.
- (4) Good samples contain 70 per cent. of calcium phosphate.
- (5) Difficult to reduce to a fine powder.

12. **Spanish and Portuguese Phosphate.**

- (1) Yielding P_2O_5 = 76 to 86 per cent. of tricalcic phosphate.
- (2) Portugal mines inexhaustible; have not been worked owing to want of roads.

13. **German.**

- (1) Known as Nassau and Lahn phosphate.

14. **South Carolina or Charleston Phosphate.**

- (1) Closely resembles the coprolites of London basin.
- (2) Beds 12 to 18 inches thick and 50 square miles in area.
- (3) More commercial value than beds in Suffolk.

COMPOSITION OF MINERAL PHOSPHATES.

Water	12·58	{	Containing traces of N. = 25·79 of soluble bone earth, 100·00.
Organic matter	15·35		
Monocalcic phosphate	19·47		
Tricalcic „	7·59		
Calcium sulphate	37·47		
Silica	4·07		
Alkalies, iron, &c.	3·47		

Composition of Three Samples of Artificial Manure.

	1	2	3
Moisture	17.46	13.33	10.23
Water of combination and organic matter	18.82	25.51	22.65
Biphosphate of lime (monocalcic phosphate)	4.97	6.45	18.91
Equal to tricalcic phosphate rendered soluble (7.79) (10.10) (29.6)			
Insoluble phosphates	7.29	17.60	12.05
Calcium sulphate, alkaline salts, and magnesia	35.17	28.96	32.06
Insoluble silicious matter	16.29	8.15	4.10
	100	100	100
Containing nitrogen	.88	.68	1.66
Equal to ammonia	1.07	.83	2.02
Value per ton	£4 0	£4 10	£9 5
Actually sold, delivered carriage paid, station	£1 10	£7 5	£8 0

Functions of Phosphates.

1. Potassium phosphate increases diffusive rate of albumen and facilitates its movements in the plant.
2. Decomposition converts calcium phosphate ($\text{Ca}_3\text{P}_2\text{O}_8$) into potassium phosphate (K_3PO_4).
3. Phosphorised oils require potassium for elaboration.
4. Phosphates co-operate with glucose, dextrine, and starch, to organise them for general diffusion.
5. All seeds contain phosphorus.
6. Needed much by turnips and oats, but not much by wheat.

Conditions when ineffectual.

1. If phosphates are washed out by heavy rains.
2. If the soil contain a sufficient supply, then addition is of no avail.
3. If deficient in potash or other ash ingredient.

JUDGMENT REQUIRED IN SELECTING MANURES.

1. That the manure be in a fine dry and powdery condition.
2. Ability to sow it with the seed either by hand or drill.
3. To know that the chemical demands of the soil are supplied by the ingredients in the manure.
4. That the manure be pure and free from adulteration.
5. That the bone-meal should contain from 45 to 50 per cent. of calcium phosphate, 4 to $4\frac{1}{2}$ per cent. of ammonia.
6. That dissolved bones should be in a semi-soluble condition.
7. That bone-meal and $\frac{1}{4}$ -inch bones should have a good clear colour—nearly white, or of a slight yellowish tinge.
8. That dissolved bones should possess 20 per cent. of soluble matter, 10 per cent. insoluble matter, from 2 to 2.5 per cent. of ammonia.

9. In ordering quantities, always take the precaution that it corresponds to the guaranteed analysis.

F. Irrigation.

(a) Great Fertilisers.

1. Constitutes a valuable additional manure.
2. Consists in passing water through the soil.
3. Supply of water continually in motion.
Stagnant water—
 - (1) A contrast to water in motion.
 - (2) Air contained in stagnant water soon exhausted by vegetation growing on the surface.
 - (3) A fresh supply of air impeded by accumulated water.
 - (4) Stagnant water injures vegetation.
 - (5) Prevents air from promoting plant growth.
4. Onward flow of water gives fresh supply of good air.
5. Gives a favourable decomposition of matters in soil.
6. Constant supply of plant-food brought to the crop.

(b) Kinds.

1. *Hard.*
 - (1) Curdling influence on soap.
 - (2) Arises from lime (CaCO_3), held in solution by carbonic acid (CO_2) and calcium sulphate (CaSO_4).
2. *Soft.*
Does not curdle with soap.

(c) Contents.

Potash, phosphoric acid, soluble silica, &c.

(d) Values.

1. Hard waters advantageous in Wilts, Gloucester, Hants.
2. Soft waters in Western counties.
3. If containing fertilising qualities, is good for irrigation.
4. Presence of trout proof of good qualities.
5. Early produce of two or three crops of grass on a dry soil.
6. Crops are not of higher feeding condition.
7. Of great value as early food for stock.

G. Sewage.—Fertilisers are in solution and suspension.

Use.

1. Contain many impurities unknown in clear water.
2. Of use to the agriculturist where no manufacture is carried on.
3. Useful to grass land ; ploughed land with crop.
4. Land intended for corn should be prepared without a crop on it long beforehand, as sewage causes corn to run to straw on retentive subsoils.

5. Applied to land for green crops, {

Italian rye,
 cabbages,
 mangel,

} before sowing.
6. Sewage purified by percolating through the soil.

Evils.

1. Unsatisfactory if herbage is bathed in sewage, injurious to health of stock.
2. Encourages disease in milk or flesh.

Remedies.

1. Alternate periods of irrigation, purification, and rest.
2. Allow the land to dry as much as possible.
3. The water sinking draws in atmospheric air.
4. The organic matter on surface speedily decays.

(a) Influences.

1. Felt long after it is drained from the land.
2. Left behind it in the land a rich manuring of those elements plants delight in.
3. Materials dissolved in water arrested by the soil.
4. Water containing ammonium sulphate, $(\text{NH}_4)_2\text{SO}_4$, passing through the land, came out containing calcium sulphate, CaSO_4 , the soil keeping the ammonia, H_3N .
5. Water is deprived of its fertilising materials as it passes through the land.
6. Value depends on the power of the soil to separate fertilising matter contained in it.
7. Illustrates the absorptive power of soils.
8. Gives the economic use of water as a carrier and distribution of manure.

Vide 'Robert Smith's Experiments on Exmoor' to secure good pasturage.

(b) Produces Artificial Climate.

1. The water of a higher temperature than the soil.
2. Warmth imparted to the soil.

	Produce per Acre, Covered Land	Produce per Acre, Uncovered Land
Grass laid up April 15, cut } May 30 }	5,870 lbs.	2,207 lbs.
Clover lea laid up May 2, } cut June 2 }	3,460 lbs.	960 lbs.
Trefoil in above	3½ inches	1 inch
Clover in above	6 inches	1½ inch
White Dutch in above	1 to 2 inches	None
Loss of water in making } into hay }	¾ inch	¾ inch

3. Beneficial results decrease with increase of source's distance.
4. Increases crops when covered from two to six fold.
5. Produces a spring growth during winter months.
6. To be continued in cold weather three weeks.
To be continued in hot weather one week.
7. *Test.* The formation of any scum on the surface.

(c) *Cautions.*

1. Prevent injury by frost to young and tender herbage.
2. A young growth has been encouraged under water.
3. If frost comes while wet, serious injury will follow.
4. Turn water off when safe from frost.
5. Do so in the morning to give a day's drying.
6. If frost comes before it is dry set on water again.
7. Frost is severest when herbage is wet.

H. **Warping** fertilisers are in suspension.

1. Overflowing of lands with water of a muddy river.
2. Matter floats in water in motion.
3. When water rests, matter falls to the bottom.
4. Only can be done in neighbourhood of rapid rivers.
5. Successful around the Humber.
6. The clear water passes back into the river.
7. Covers lands eventually with 18 or 20 inches of richest soil.

F, A. Water of irrigation is fertilising matter added in solution.

G, B. Sewage in irrigation is fertilising matter added in solution and suspension.

H, C. Warping in irrigation is fertilising matter added in suspension.

Conditions of Success of Irrigation.

Under A, F, G, B, a thoroughly good under drainage, either naturally or artificially, is necessary.

Reasons. 1. Vegetation needs atmospheric air.

2. Cannot keep the plant long without air.

3. Plant uses the air in the moving water.

4. Limited supply not sufficient for luxuriant growth.

5. Absolutely necessary to stop for plants to breathe in the overflow of water, and especially town sewage.

6. Air is necessary to regulate the decompositions taking place in the land.

Plants suitable.

1. Grasses differ according to soil on which they grow.
2. Each variety of grass requires definite set of conditions.
3. If favourable, plant luxuriates.
4. If unfavourable, makes feeble growth.
5. If very unfavourable, dies.

PART IV.

ROOT CROPS.

A. Mangold Wurzel.

1. Brought to a very high success in this kingdom.
2. Origin from sea beet preserves some ancient qualities.
3. Cultivated for producing food for cattle ; can be removed and stored for use.
4. Successfully grown on clays and clay loams.
5. Flourishes on stronger soils than swede turnip.
6. In sowing, allow active tillage between drills. Land is thus freed from weeds, and exposed to air.
7. The value of the root determined by its specific gravity.
8. The greater its weight in water, the greater feeding quality.

Manures.

1. By properly selected manures, the roots on the same land may be grown more or less densely.
2. Phosphates in slowly available condition bring denser roots.
3. Very soluble phosphates, sulphate of ammonia, and nitrate of soda produce lighter roots in specific gravity.
4. Heaviest crops produced from stimulating nitrogenous manures.
5. Best crops from phosphates.
6. Conditions of soil and climate modify these results.
7. Have due regard to condition of soil in using your manure.
8. More food and less whip often desirable.

Object of Growth.

1. To produce roots which can be stored and preserved.
2. The keeping power the great desideratum.
3. Must be properly ripened before used.
4. Gathered, stored, to ripen in the heap.
5. Thousands of tons yearly lost because gathered too ripe.
6. Warm summer may ripen.
7. *A sharp frost ripens a mangold at once.*

8. The frost-touched part is immediately chemically changed.
9. The densest and not largest roots keep the best.
10. Good cultivation shown by—
 - (a) Producing larger number of smaller roots.
 - (b) Slow and steady growth.
 - (c) Stored in thoroughly unripe condition.
 - (d) More nutritive and larger amount of sugar secured.
11. Roots ripen gently with warmth of heap.

Growth of Mangold Wurzel.

Manure used	Specific Gravity	Weight per Acre
		tous cwt.
Reduced superphosphate and bone meal	1·053	33 7
Reduced superphosphate	1·028	32 14
Bone meal	1·023	32 14
Reduced superphosphate and superphosphate	1·022	32 10
Blood and sulphate of ammonia	1·018	36 7
Superphosphate and sulphate of ammonia	1·017	34 3½
Blood and reduced superphosphate	1·016	35 10
Bone and sulphate of ammonia	1·014	37 0
Blood	1·014	38 0
No manure	1·013	27 0
Superphosphate	1·012	31 7
Nitrate of soda and superphosphate	1·011	38 10
Nitrate of soda and bone	1·010	34 4
Nitrate of soda and sulphate of ammonia	1·009	38 13½
Sulphate of ammonia	1·008	34 3½
Nitrate of soda	1·007	36 17½
Nitrate of soda and blood	1·004	39 10
Nitrate of soda (double quantity)	·995	43 0

B. Turnips.

Several varieties different in character to meet the various requirements of climate, soil, and time wanted.

- (a) Quick growth ; summer produce matured in autumn.
- (b) Hardy swede.
- (c) Tankard.
- (d) Hybrid.

Amount of Food.—6 per cent. of good turnips ; 10 or 11 per cent. of good swedes ; the remaining amount in water. This water to be raised to the temperature of the body. Much of it to be evaporated from the body.

Growth.—1. Excessive rapidity produces heavy weight of valueless food.

2. Active growth to secure success.
3. This point most valuable in moderation ; objectionable in excess.

4. Attacks of turnip beetle.

Cures.—(1) Sow a larger quantity of seed and use strong manure :

(2) To push the young plant into rough leaf.

(3) These plans appear weak and faulty.

(4) Buckman says it draws the early broods from the field.

(5) Sow mustard over the field, to be fed upon in the bottom of the stitches.

(6) The young plant allowed to make growth under favourable conditions.

5. Rapid progress assisted by very soluble manures.

6. The rapid race not checked until nearly completed.

7. The slower-grown plants appear left far behind.

8. Suddenly in hot weather the former fast crop is checked by mildew.

9. The minute fungi draw the nourishment from the plant.

10. The slower crop is strong enough to resist hot season.

Weight and Composition of Swedes.

Group	Specific gravity	Percentage of available flesh-formers
No. 7	1·0300	·779
„ 2	1·0296	·671
„ 1	1·0293	·671
„ 5	1·0285	·608
„ 3	1·0278	·520
„ 6	1·0250	·570
„ 4	1·0189	·494

11. Mildew not established on them.

12. Growth maintained ; cells receive rich food.

13. The rapidly-grown crop forms large bulbs ; they sound empty, and float like corks.

14. Latter, moderate bulbs ; solid, heavy, and sink in water.

15. Quickly-grown turnips when exposed to moderate frost quickly rot.

16. Slowly-grown remain firm and steady for food.

17. The feeding qualities of slower growth are greater than those of the others.

Ripening of Swedes.

1. Often accomplished by action of frost.

2. Only a small proportion ripened by warmth.

3. Under influence of frost, diastase formed.

Proportion of Solid Food.

1. Only a small amount in our best swedes and turnips.

2. *Never should be relied upon as animals' only food.*

3. *Dry food is necessary as a supplement.*

4. Great mistake to keep stock on unsatisfying food.
5. The losses in our ewe flocks attributable to this cause.
6. Worst economy for food to be unequal to its duty.
7. Supplemental food to be of dry character when given with swedes and turnips.
8. Corn, oil cake, and meal judiciously employed improve the food and enrich the soil.

The Turnip Crop.

Distances between the Drills	Distances between the Plants	Area of Surface occupied by Plant	Number of Plants to the Acre	Weight of each Turnip	Weight of Crop per Acre	
inches	inches	sqr. inches		lbs.	tons	cwt.
27	9 for white turnips	243	25,813	1	11	10½
				2	23	1
				3	34	11½
				4	46	2
				5	57	12½
				6	69	3
				7	80	13½
				8	92	4
27	10 for yellow turnips	270	23,232	1	10	7
				2	20	14
				3	31	1
				4	41	8
				5	51	15
				6	62	2
				7	72	9
				8	82	16
27	11	297	21,120	1	9	8
				2	18	7½
				3	28	5
				4	37	14½
				5	47	2
				6	56	11½
				7	65	19
				8	75	8½
27	12 for swedes	324	19,360	1	8	12½
				2	17	0
				3	25	18½
				4	34	11
				5	43	3¼
				6	51	16½
				7	60	9¼
				8	69	2

C. Clover.

Importance.—Next to grasses, no plant holds such an important position to the farmer, and offers such an interesting analogy in its formation.

- I. Thus in *graminaceous* plants we have cereal or corn seed products and meadow and pasture herbs.
- II. In *leguminous* plants we have a seed-producing group termed pulse, and a herb-growing green food or fodder series.

- (1) Wholly the results of arable culture.
- (2) Under conditions called pasture. Leguminosæ implies two-valved seed pods.

SPECIES.

- I. Flowers red or purple.
 1. *Trifolium pratense*—Broad-leaved clover.
 2. „ medium—Zigzag, or cow-grass.
 3. „ incarnatum—Carnation clover.
- II. Flowers pink.
 1. *Trifolium hybridum*—Alsike.
 2. „ fragiferum—Strawberry-headed clover.
- III. Flowers white.
 1. *Trifolium repens*—Dutch clover.
- IV. Flowers yellow.
 1. *Trifolium filiforme*—Suckling clover.
 2. „ procumbens—Hop clover.

Definition.—Not only true clovers (*trifolium*) but a series of leguminous plants differing in character from grasses, and are termed *artificial grasses*.

Cultivation.

1. Becoming daily more important.
2. Its difficulties interfering with successful cultivation.
3. *Clover Sickness.*
 - (1) The soil's condition not permitting a successful cultivation.
 - (2) The soil exhausted of the necessary substances.
 - (3) The mechanical condition of the soil another hindrance or cause.
 - (4) The plant is prevented from searching for food.
 - (5) Early loss of vitality after growth commenced.
 - (a) Caused by seed grown in warmer climate.
 - (b) Too delicate to withstand the trying weather.
 - (c) A want of alkaline matters in the soil.
 - (d) Plant should have time, but not too long, to extend roots beneath, and stems to grow above the soil.
 - (e) Excess of foliage among the grain weakens the succeeding crop.

4. Foliage not eaten in its first autumn is not thrown away.
5. It is reproduced in the next spring, and plant is strengthened.
6. A warm and moist season forces rapid and feeble growth, their energy thus misdirected.
7. Further injured by sheep grazing on it.

Application of Farmyard Manure to Clover.

1. Produced most satisfactory results.
2. Prepares the plant for strong and successful growth.
3. Clover root exercises great influence on soil's fertility.
4. The surface of clay soils mellowed in a superior manner.
5. *General Results.* Intermixture of rich organic matter improves fertility.
6. Modifies the nature of sands and sandy loams.
7. Hungry soils altered by growth of clover.
8. The organic matter added enables the soil to keep manure.
9. Greatly enriches and increases plant food.

Mode of Cultivation.

1. Allowing plant to attain full growth, then mow it.
2. Take two cuttings rather than feed off.
3. More and better wheat after two cuttings than one cutting.
4. Success of the wheat depends on the non-ripening of the clover seed.
5. The soil loses inorganic matter, but gains a greater value in exchange by nitrogen.
6. A most valuable and expensive fertiliser.
7. The energies of the plant shown in the cut crop.
8. Mowing stops formation of seed and preserves the nitrogen for future work.
9. The proper cultivation of clover plant of the highest importance for successful tillage of soil.

Rotation of Crops.

1. Very important to regulate succession of crops.
2. Sickness of one crop shows a want of one or more particular elements.
3. Slightly differs in various districts.
4. Exercises great influence upon successful farming.
5. De Candolle's theory was that plants threw off an excrementitious matter injurious to the succeeding crops, which died in consequence.
6. Liebig's theory: The plant required food no longer supplied by soil.
7. Shown by the number of different substances required by plants.
8. Insufficiency of food for one plant may be sufficiency for another.
9. The former would fail while latter prospered.

Rules Regulating Rotation.

1. Those plants requiring the same kind of food to be kept as far apart as possible.
2. Those requiring different supplies to follow each other.
3. Plants of the same habit of growth and general character not to follow each other.
4. Equally distribute the work throughout the year to give variety of food and litter required on farm.

Examples.

1. Some plants seek their food from lower portions of soil.
2. Some from surface soil.
3. Clover strikes deeply and enriches upper surface.
4. Wheat grows luxuriantly where clover flourished.
5. Good clover leys promise fine crops of wheat.
 - (a) Clover has drawn from a depth and stored its nitrogenous matter in upper soil.
 - (b) Wheat roots find freedom for growth among the supplies.
6. Good bean crop after wheat.
 - (a) Wheat requires large supply of double silicates.
 - (b) Beans are tenth the quantity.
 - (c) Wheat requires $\frac{1}{4}$ potash (K_2CO_3) and $\frac{1}{2}$ phosphoric acid (H_3PO_4) that beans need.
7. Rotation of cropping may be dispensed with if the land be fully supplied with the plants' requirements.
1. *Norfolk*, or four-course, system.

Turnips or roots.
Barley.
Clover.
Wheat.

Advantages.—(1) Turnips thoroughly cleanse the land.

- (2) Convenient time for manuring.
- (3) Land prepared for barley.
- (4) Clover seeds sown amongst it.
- (5) Strong clover checks growth of weeds.
- (6) Good clover ley fine condition for wheat.

2. *Norfolk modified.*

Turnips or roots.
Barley.
Clover.
Clover.
Wheat.

- (1) Some lands not good enough to bear corn so often.
- (2) Fertilising matter not so liberally added.
- (3) Roots, barley, clover, clover, wheat.

3. *Cumberland system, five course.*

Oats.

Roots.

Wheat, barley, or oats.

Clover.

Graze.

Advantages.—(1) Land so fertile obliged to grow more corn.

(2) Barley so strong and coarse as to lose quality.

(3) Clover to follow wheat.

Seed required to sow an Acre.

Barley	2½ to 2¾ bushels
Beans	2 to 2½ bushels
Beet	12 lbs.
Bromus Schroederi	60 lbs.
Broom (for cover)	20 lbs.
Buckwheat	2 bushels
Burnet	40 lbs.
Cabbage, in drills	5 to 6 lbs.
„ for transplanting	1 lb.
Canary	3 pecks
Carrot	8 to 10 lbs.
Chicory	8 lbs.
Clover	16 lbs.
Fenugreek	30 lbs.
Gorse, for clover	30 lbs.
„ for cutting	50 lbs.
Grass seed for pastures	} 2 to 2½ bushels with 12 lbs. clover
„ „ cricket grounds, &c.	
„ „ lawns and grounds	2½ to 3 bushels
„ „ shades and orchards	} 2 bushels, with 12 lbs. clover
„ „ sewage farms	
„ „ renovating pastures	6 to 12 lbs.
Holcus saccharatus	20 lbs.
Kohl Rabi, to transplant	1 lb.
„ in drills	4 lbs.
Linseed	2½ bushels
„ for seed	1½ bushel
Lucerne	20 lbs.
„ drilled	15 lbs.
Lupin	3 bushels
Mangold Wurzel	6 to 8 lbs.
Mustard	3 gallons or 20 lbs.
Oats	3 to 4 bushels

Paranips	8 lbs.
Peas	3 bushels
Potatoes	about 24 bushels
Rape	1 gallon
Rye	2½ to 3 bushels
Rye grass	3 bushels
„ drilled	2½ bushels
„ and clover	1 peck grass, with 14 lbs. clover
Sainfoin in husk	5 bushels
„ milled	56 lbs.
Serradella	28 lbs.
Sheep's parsley	20 lbs.
Sunflower	8 lbs.
Swedes	3 lbs.
Tares, spring	2 to 2½ bushels
„ winter	2½ bushels
Trifolium	24 lbs.
Turnips, yellow-fleshed	3 lbs.
„ white-fleshed	3 to 4 lbs.
Wheat	2 to 2½ bushels

Demands by Various Crops.

I. Wheat, 325.

Silica	102·66
Potash	25·70
Phosphoric acid	19·62
Magnesia	7·00

II. Beans, 231.

K_2CO_3 =	111·8
$CaCO_3$ =	37·21
H_3PO_4 =	35·83
MgO =	16·27
SiO_2 =	12·56
$NaCl$ =	8·00

III. Turnips, 640.

K_2CO_3 =	201·68
$CaCO_3$ =	107·68
H_2SO_4 =	78·82
H_3PO_4 =	58·98
$NaCl$ =	66·84
Na_2CO_3 =	39·21
CO_2 =	42·7

IV. Clover, 259.

Lime	111
Potash	52
Magnesia	35
Phosphoric acid	20
Sulphuric acid	13

V. Barley, 200.

Silica	97·9
Phosphoric acid	42·00
Potash	21·1

VI. Potatoes.

Potash	55·75
H_2SO_4	13·65
H_3PO_4	12·57

Feeding Stuffs.

	Peas	Beans	Maize	Wheat	Barley	Oats	Bran
Water	9·6	17·5	14·3	10·0	14·4	16·0	13·1
Albumen or flesh-forming	27·4	26·3	9·5	11·0	10·0	18·0	19·3
Fatty matter, starch, gum, &c.	2·0	3·0	2·5	3·3	7·0	5·44	4·7
Fibre	47·0	41·0	64·1	70·7	61·0	46·01	—
Saline matter	11·0	8·0	7·0	—	5·5	10·53	55·6
	3·0	4·2	2·6	5·0	2·1	4·02	7·3
	100	100	100	100	100	100	100
Calculated total amount of nutrition in 1 ton	£ s. d. 3 19 0	£ s. d. 3 14 0	£ s. d. 4 0 0	£ s. d. 4 2 0	£ s. d. 4 2 0	£ s. d. 3 19 0	
Calculated total amount manurial properties in 1 ton	£ s. d. 3 2 6	£ s. d. 3 2 0	£ s. d. 1 5 0	£ s. d. 1 7 0	£ s. d. 1 5 0	£ s. d. 1 3 0	£ s. d. 2 15 0

PART V.

GRASSES AND CLOVERS.

GRASSES.

How to Grow good Grasses.

(a) **Meadow** is that area occupied by permanent pasture. Old pasture is the result of cultivation. If it had been left to nature it would soon have resumed the original jungle, moors, or marsh, according to soil, climate, and situation.

(b) **Permanent Pasture**, of five kinds :—

I. Moors and uplands.

II. Commons.

III. River flats and lowlands.

IV. Irrigated meadows (water controllable).

V. Meadows, permanent grass enclosed.

I. Moors and Uplands.

Without any fences at all.

Never used for hay.

Support fewer animals.

On round downs and fell sides.

II. Commons.

Best species of grass found on commons.

Absence of weeds.

Improved by drainage.

III. River Flats and Lowlands.

These would be improved by constant haymaking.

A deposit of silt which has been left by water from the winter floods.

Occur on the banks of the Severn and Thames.

Have the name of Ham.

Good herbage.

For want of good drainage the hay in summer is often lost from the rough freshets.

IV. Irrigated Meadows by water containing matter in suspension.

A full command of water necessary.

Water capable of flowing through, not pouring over and standing on the land ; this is flooding.

Drainage should be so perfect that the land be sound enough to walk over dry in a few hours after the water has been turned off.

It augments, supplies and produces earlier grass.

Brings a fresh green pasture.

Of great utility for fattening early.

By irrigation land is increased from 30s. to 5*l.* per acre in four years.

Annual cost of the drowner, *i.e.* he who manages several acres, is about 6s. per acre.

Good succulent herbage present.

Tussac grass a good evidence of stagnant water.

Evidence of changes as process proceeds.

Name	Before Irrigation	After 2 years' Irrigation	After 4 years' Irrigation
Meadow foxtail . .	1	2	4
Field meadow grass . .	2	2	4
Rough stalked grass . .	1	2	1
Quaking grass	2	0	0
Dog's-tail grass	2	1	0
Tussac grass	1	0	0
Marsh bent grass	1	2	3
Cocksfoot grass	1	2	3
Yellow oat grass	2	3	3
Soft oat grass	1	1	1
Meadow barley	1	2	2
Perennial rye grass	2	4	6
Meadow crowfoot	1	3	1
Bulbous grass	3	1	0
Narrow-leaved grass	3	1	1
Broad-leaved grass	3	0	0
Dutch clover grass	2	0	0
Broad clover grass	1	2	2
Common beaked parsley . .	1	2	1

The general conclusion from this table is that large and nutritious herbage is destroyed, and the place occupied by good nutritious grass.

V. Meadows or Permanent Pasture.

The laying down of meadows is an ancient as well as a modern practice.

Seen by the furrows in old fields.

The former process was by sowing the seeds from a hay loft.

1. Preparation of the land.

2. Kinds of seed adopted.

3. The after treatment of the new meadow.

1. Preparation of the Land.

Generally sowing the seeds with the white crop.

Come to perfection the second year.

After turnips have been fed off make the ground level as possible.

Harrow and roll it smooth.

On the surface carefully sow your mixture.

Light harrow it and then roll.

2. Kinds of Seeds to be sown.

Although few in number, will vary according to soil and situation.

Leave out coarse grasses, as red canary grass for damp meadows, and annual grasses, as Italian rye, and useless varieties, as *Poa nemoralis*.

Remember the better, the useless, and annual grasses.

For rich loams in best grass-growing positions.

Botanical Name	Trivial Name	Quantity per acre	
		lbs.	ozs.
<i>Lolium perenne</i> . . .	Perennial rye . . .	10	0
<i>Poa pratensis</i> . . .	Meadow grass . . .	2	0
<i>Dactylis glomerata</i> . . .	Cocksfoot . . .	5	0
<i>Festuca pratensis</i> . . .	Meadow fescue . . .	3	0
„ <i>duriuscula</i> . . .	Hard „ . . .	3	0
<i>Alopecurus pratensis</i> . . .	Foxtail . . .	2	0
<i>Phleum pratense</i> . . .	Catstail . . .	2	0
<i>Anthoxanthum odoratum</i> . . .	Sweet vernal . . .	0	8
<i>Trifolium pratense</i> . . .	Common clover . . .	4	0
„ <i>repens</i> . . .	Dutch „ . . .	2	0

Poor stiff soil on clay subsoil.

Botanical Name	Trivial Name	Quantity per acre	
		lbs.	ozs.
<i>Lolium perenne</i> . . .	Perennial rye . . .	12	0
<i>Poa pratensis</i> . . .	Smooth meadow grass	3	0
„ <i>trivialis</i> . . .	Rough „ . . .	2	0
<i>Festuca loliacea</i> . . .	<i>Lolium fescue</i> . . .	2	0
„ <i>duriuscula</i> . . .	Hard „ . . .	2	0
<i>Phleum pratense</i> . . .	Catstail . . .	2	0
<i>Dactylis glomerata</i> . . .	Cocksfoot . . .	6	0
<i>Anthoxanthum odoratum</i> . . .	Sweet vernal . . .	0	8
<i>Trifolium pratense</i> . . .	Common clover . . .	6	0
„ <i>repens</i> . . .	Dutch „ . . .	2	0

Thin uplands on calcareous soils.

Botanical Name	Trivial Name	Quantity per acre	
		lbs.	ozs.
Lolium perenne . . .	Perennial rye . . .	12	0
Poa pratensis . . .	Smooth meadow grass . . .	4	0
Festuca ovina . . .	Sheep's fescue . . .	2	0
„ duriuscula . . .	Hard „ . . .	2	0
Avena flavescens . . .	Yellow oat grass . . .	1	0
„ pubescens . . .	Soft „ . . .	1	0
Anthoxanthum odoratum . . .	Sweet vernal . . .	1	0
Trifolium pratense . . .	Common clover . . .	3	0
„ repens . . .	Dutch „ . . .	3	0
Achillea millefolia . . .	Yarrow . . .	0	8

Light soils on sands.

Botanical Name	Trivial Name	Quantity per acre	
		lbs.	ozs.
Lolium perenne . . .	Perennial rye . . .	14	0
Poa pratensis . . .	Smooth meadow grass . . .	3	0
Festuca duriuscula . . .	Hard fescue . . .	3	0
Avena flavescens . . .	Soft oat grass . . .	1	0
Anthoxanthum odoratum . . .	Sweet vernal . . .	0	8
Trifolium medium . . .	Zigzag clover . . .	4	0
„ pratense . . .	Corn „ . . .	2	0
„ repens . . .	Dutch „ . . .	5	0
Lotus corniculatus . . .	Birdsfoot trefoil . . .	0	8
Achillea millefolia . . .	Yarrow . . .	0	8

For strong land generally.

Botanical Name	Trivial Name	Quantity per acre	
		lbs.	ozs.
Poa pratensis . . .	Meadow grass . . .	3	0
Lolium perenne . . .	Perennial rye . . .	3	0
Festuca duriuscula . . .	Fescue . . .	5	0
Dactylis glomerata . . .	Cocksfoot . . .	4	4
Lolium perenne Paceyannum . . .	Pacey's rye grass . . .	5	0
Lolium italicum . . .	Italian rye . . .	4	4
Trifolium repens . . .	White clover . . .	7	4
„ hybridum . . .	Alsike „ . . .	2	0
„ medium . . .	Cow grass . . .	2	0

This to be sown with 15 cwt. of bone manure.

Care to be observed in selection.

Newer and fresher the better.

Procure seeds separately and mix yourself.

Have your seeds guaranteed and then tested.

3. After treatment of new meadow.

In first year seek out carefully all weeds.

Spud them out before they can seed.

In January following the sowing give a dressing of not over-rotten manure.

In February or March bush-harrow, and then roll.

If any grasses are thrown out use the crosskill.

In May stock with sufficient sheep to prevent any extensive seeding.

In next year resow vacant spaces.

Mix the seeds with a little guano and soot.

Management of Permanent Pastures.

Objects.

1. To keep them in good condition.
2. If not good, improve them.

Means adopted.

1. Weed out all rubbish.

More grasses and less rubbish, the greater the produce in quantity and quality.

2. Drainage.

Criteria.

Sedges	.	.	.	.	.	} Show a want of thorough drainage.	} Full drainage certainly required.	
Rushes	.	.	.	.	.			} Perhaps partial or grip drainage may do.
Bull pates and coarse grasses	.	.	.	.	.			
Devil's-bit scabious, buttercups	.	.	.	.	.			
Lousewort	.	.	.	.	.			
Field orchids	.	.	.	.	.			
Cowslips	.	.	.	.	.			
Moss	.	.	.	.	.			

1. In wet meadows seldom if ever manured.
2. Land full of moist *humus*.
3. Manure would not tend to increase of good grass.
4. Might increase thistles and buttercups.
5. Sound meadows not to be too much cut for hay.
6. Cheshire pastures a good example of increasing poverty.
7. Grass is gone in hay, bones, and cheese.
8. Salt will kill rough and improve good grasses.
9. Here an evidence of different elements required by different plants.
10. Do not ripen grasses too much before cutting.

11. Restore the phosphates lost by mowing.
12. Use heavy rollers in spring to smooth and consolidate the soil.
13. To replant any roots that might be thrown out.
14. To mat the turf more thoroughly together.
15. Ameliorate the soil by rubbish of all kinds where it is too tenacious.
16. Manure by farmyard dung, bones, superphosphate, guano, nitrates, soot, &c., the sheet anchors of the pastures' improvement.
17. Hence make two blades of good grass grow where one did before.

Species of Meadow Grass.

1. More than 100 species of grass.
2. Rarely more than quarter of them in a range of meadows.
3. If more than quarter an argument against them.
4. The wider the range the less the quality.
5. If good grasses be few, bad must be numerous.
6. Called sour from acidity of flavour, a strong indication of the want of alkalies.

Meadow Foxtail.

1. Early species of closely flowering grass.
2. Yields plentiful herbage in moist situations.
3. Well adapted for irrigated meadow.
4. Must be distinguished from kneeling Foxtail.
5. Spike only half the length and size.
6. This last a particularly water species.
7. Where found denotes good water supply.
8. It must be distinguished from slender Foxtail.
 - (a) A long thin spike.
 - (b) Only a weed in hungry clays.
 - (c) Indicates a want of drainage and manure.

Cat's-tail or Timothy (*Phleum pratense*).

1. Not much unlike Foxtail.
2. Rougher in all its parts.
3. One of the latest species, good for supplying a late crop.
4. Large fields, mostly by itself, grown in Canada.
5. Augments herbage in colder but not poorer districts.

Sweet Vernal (*Anthoxanthum odoratum*).

1. Very early species.
2. A lax spike of flowers.
3. Bright straw colour when hayfield is ripe.
4. Does not yield much bulk, but a grateful bitter when fresh.
5. Peculiarly sweet hayfield odour when drying.
6. Important in raising the value of a meadow hay.

Crested Dog's-tail (*Cynosurus cristatus*).

1. Its florets arranged in front on a series of abortive branches.

2. A slender stem, hard and wiry when ripe.
3. Particularly innutritious, and its herbage of very little value.

Rye Grass (*Lolium perenne*).

1. Most common and useful species.
2. No connection with Cereal Rye.
3. Yields good bulk for the rick.
4. Readily grows after cutting or close depasturing.
5. Affords the greatest part of the herbage of a pasture.
6. From its value its seeds much cultivated.
7. Has a tendency to form more or less permanent varieties.
8. Should always form a part of any mixture in laying down a permanent pasture.
9. Should be distinguished from *Italian Rye*.
 - (a) Florets and seeds being awn-pointed.
 - (b) Useful as annual self-crop.
 - (c) Seedsman often mix it in permanent pasture collections.
 - (d) Makes a show in first year, and deceives customer.
 - (e) Soon dies out, and its large growth keeps under more enduring forms.

Cock's-foot (*Dactylis glomerata*).

1. A large and somewhat coarse grass.
2. Not inferior in quality.
3. Its hay highly nutritious.
4. Its cut or cropped herbage quick in growth.
5. Capable of yielding a great deal of keep.
6. Its root runs deep into the soil.
7. Grows well in poor land, if dry.
8. Never flourishes in wet situations.
9. Constant in good meadows unless always depastured.
10. Constant treading greatly interferes with it.
11. Never abundant in sheep pastures.
12. Well roll the meadow once or twice a year.
13. Prevents tussocks of cock's-foot.

Rough-stalked Meadow Grass (*Poa trivialis*).

1. Common species in moist meadows.
2. Distinguished from smooth-stalked by long pointed tongue to the leaves, and stem when drawn downwards through the fingers.
3. Yields a quantity of herbage.
4. Is wanting in feeding qualities or 'proof.'
5. Forms a large part of the irrigated meadow hay.

Smooth-stalked Meadow Grass (*Poa pratensis*).

1. Blunt ligule and smooth stem.
2. Abundant in dry situations.
3. Varies with soil and situation.

4. If growing on a wild moor is poor in quantity and quality.
5. Its increase shows improvement of a bad meadow.

Wood Meadow Grass (*Poa nemoralis*).

1. Slender in form.
2. Its wild habitat is in woods and shady places.
3. Useful for wood glades and positions beneath trees.

Meadow Fescue (*Festuca pratensis*).

1. A good type of the broad-leaved fescues.
2. Common and good succulent grass in rich meadows.
3. The unbranched variety found on banks of Isis, and forms excellent herbage.

Tall Fescue (*Festuca elatior*).

1. Coarser form than meadow fescue.
2. Latter will become former if sown on stiff sandy soils.
3. Coarse grass has a tendency to grow in bunches.
4. Destructive to good pastures.

Sheep's Fescue (*Festuca ovina*).

1. Type of small-leaved fescues.
2. A large portion of down pasturage.
3. Its fine leaves come up immediately after feeding.
4. Its quality far exceeds its quantity.

Oat-like Grasses.

1. *Downy wild oat* (*Avena pubescens*).
 - (a) Common on thin calcareous soils.
 - (b) Light in structure, yields but little grass.
2. *Yellow oat grass* (*Avena pratensis*).
 - (a) Found too frequently in poor clays.
 - (b) Its rigid leaves and harshness make it little better than a weed.
3. *Wild oat* (*Avena fatua*).
 - (a) A well-known weed in stiff arable soils.
 - (b) The parent of the cultivated oat.
 - (c) The crop oat by degeneracy leaves a pest of wild oats.
4. *Oat-like grass* (*Arrhenatherum avenaceum*).
 - (a) Tall succulent-looking species.
 - (b) Common in poor soils.
 - (c) Herbage bitter and nauseous, and its hay very inferior.
5. *Onion couch*.
 - (a) Its nodes thicken below the soil like onions.
 - (b) Destroyed by harrowing and hand picking.
 - (c) Each bulb grows like joints of real couch.

Soft Brome or Lop Grasses (*Bromus mollis*).

1. An annual grass, becomes attached to poor land.
2. Destroyed by manuring and depasturing.
3. Haymaking encourages its growth.

4. Often mixed by dishonest seedsmen with rye grass.
5. Its seeds are heavy and large.

Upright Brome Grass (*Bromus erectus*).

1. Constant to poor calcareous soils.
2. Perennial, green in park glades, may be useful.

Bent Grass (*Agrostis stolonifera*).

1. Under name of florin much extolled for meadows.
2. Varies in value according to its position.
3. In irrigated meadow, heavy in rich pasturage.
4. In dry districts it is hard and harsh.
5. An underground creeping stem and a mischievous couch.
6. A pernicious weed in thin soils.

Woolly Soft Grass (*Holcus lanatus*).

1. Worthless in feeding properties.
2. Too abundant in some moist meadows.
3. Speaks of poverty as well as wet.
4. Improved by draining.
 - (a) Frequent haymaking.
 - (b) Liberal doses of manure.

Quaking Grasses (*Briza media*).

1. Pretty, but useless to the farmer.
2. Common species well known in all wet poor clay meadows.
3. Where abundant, calculate on less than a ton to the acre.
4. Generally late, little or no fogge or aftermath.
5. Shows want of draining, manure, and depasturing.
6. Sheep fed on it, after draining, with turnips, hay, peas, or cake, soon eradicated the grass.

Minor—Small species, annual.

Small bunches of whitish flowers.

Branches rectilinear.

Major—Purple flowers in large bunches.

Grows in gardens.

Hair Grass (*Aira cæspitosa*).

1. Various names, hassock, tussac, bull pates.
2. Leaves very rough with serrated edges.
3. Cattle mostly refuse it unless it is young.
4. A never-failing indicator of wet.
5. Land where drained causes a gradual disappearance.
6. After drainage fold sheep on the land.
7. Tussac grass then trodden into manure, which feeds the better species.
8. Other rough sour grasses are destroyed.
9. In the meadow there will generally be found two sets of grasses growing together.
10. Grasses more or less nutritious—sweet.
11. Grasses more or less innutritious—sour.

Pasture Weeds.**I. Plants which take up space but yield no produce.**

Trivial Name	Botanical Name	Remarks
Broad-leaved plantain	Plantago media .	{ The leaves of these plants grow too close to the ground to be eaten off by cattle or to cut for hay.
Dent-de-lion	Leontodon taraxacum	
Daisy	Bellis perennis .	
Cowslip	Primula veris .	{ These plants take up much room in growing, they are not eaten by cattle, and as they die before haymaking, yield little or nothing to the rick.
Primrose	" vulgaris .	
Green-winged orchis	Orchis Morio .	
Early purple orchis .	" mascula .	

II. Plants which take up space, but simply dilute the hay with useless matter.

Trivial Name	Botanical Name	Remarks
Blunt-leaved dock .	Rumex obtusifolius .	{ All common, especially in damp meadows, are not usually depastured, and have little or no feeding properties when made into hay.
Crisp-leaved " .	" crispus .	
Marsh " .	" palustris .	
Field sorrel	" Acetosa .	
Burdock	Arctium Lappa .	{ Common about the borders of fields.
Butterbur	Petasites vulgaris	{ Common near water-courses.
Cow parsnip	Heracleum Sphondylium	{ Very common and unsightly in pastures.
Wild-beaked parsley	Anthriscus vulgaris	
Ladies' smock . . .	Cardamine pratensis	{ In damp places.
Yellow rattle	Rhinanthus cristagalli	{ In poor cold clays.
Larger hawkweeds .	Hieracium, species	{ About fields in upland districts.

III. Mechanical Plants. Those with spikes, prickles, stings, &c.

Trivial Name	Botanical Name	Remarks
Musk thistle . . .	<i>Carduus nutans</i> .	{ Mostly a weed in fields.
Wetted " . . .	" <i>acanthoides</i> .	
Creeping " . . .	" <i>arvensis</i> .	{ In hedgerows, borders of fields, on the open meadows.
Cotton " . . .	" <i>eriphorus</i> .	
Spear " . . .	" <i>lanceolatus</i> .	{ Damp or marsh meadows.
Marsh plume thistle	" <i>palustris</i> .	
Meadow " . . .	" <i>pratensis</i> .	{ Common to poor calcareous uplands.
Stemless " . . .	" <i>acaulis</i> .	
Carline " . . .	<i>Carlina vulgaris</i> .	{ About the homestead, corners of fields, &c.
Common stinging nettle . . .	<i>Urtica dioica</i> .	
Smaller stinging nettle . . .	" <i>urens</i> .	{ About sandy soils, both in the meadow and arable.
Wall barley . . .	<i>Hordeum murium</i>	

IV. Poisonous Pasture Weeds.

Trivial Name	Botanical Name	Remarks
Meadow saffron . .	<i>Colchicum autumnale</i> . . .	{ Usual in calcareous soils or marls.
Upright buttercup .	<i>Ranunculus acris</i> .	
Diseased grasses .	<i>Secale cornutum</i> .	{ In damp meadows.
		{ In places where mist and damp prevail.

V. Ill-favoured Weeds or Plants which communicate bad flavour to Produce.

Trivial Name	Botanical Name	Remarks
Crow garlic . . .	<i>Allium vineale</i> .	{ More or less in meadows and corners of fields.
Hog's garlic . . .	" <i>ursinum</i> .	
Tuck-by-the-hedge .	<i>Erysimum Alliaria</i>	About the hedgerow.

VI. *Useless Grasses or Grass-like Plants.*

Trivial Name	Botanical Name	Remarks
Rough grasses . . .	Species . . .	{ Poor land and wet places.
Sedges	Species . . .	{ In boggy, marshy, or wet sandy spots.
Rushes	Species . . .	{ In sandy spots, on clays and poor soils.

THE LAZY FARMER'S EXCUSE FOR NOT MAKING AN EARLY SUMMER ATTACK ON THISTLES AND NETTLES.

If thistles be cut in April,
 They appear in a little while.
 If in May,
 They peep out the next day.
 If cut in June,
 They appear very soon.
 If in July,
 They'll hardly die.
 If cut in August,
 Die they must.

CLOVERS.

1. Important adjuncts to the fodder plants on farm.
2. Next in value to the grasses.
3. The graminaceous plants have cereal products.
4. The leguminous plants have pulse.
5. Grass cereals, the result of arable culture.
6. Fodder grasses grown under conditions of pasture.
7. Peas and beans belong exclusively to the arable farm.
8. Clover mixes with grass of the meadow or by itself in shifting green crops.
9. Flowers varied in size and colour.
10. Their construction exactly the same as the pea or bean.
11. Each seed contains an oval eye or hilum, and separates into two cotyledons.
12. All true clovers belong to the genus *Trifolium*.

FLOWERS RED OR PURPLE.

1. *Trifolium pratense*—Broad-leaved clover.
2. „ *medium*—Zigzag or true cow-grass clover.
3. „ *incarnatum*—Carnation clover.

FLOWERS PINK.

4. „ *hybridum*—Alsike clover.
5. „ *fragiferum*—Strawberry-headed clover.

FLOWERS WHITE.

- 6.
- Trifolium repens*
- Dutch clover.

FLOWERS YELLOW.

7. „ filiforme—Suckling clover.

8. „ procumbens—Hop clover.

- 1.
- Trifolium pratense*
- . Meadow or broad-leaved.

(1) In wild state runs to many variations.

(2) Permanent.

(3) Some sorts biennial.

Characters of Clovers.

1. <i>Trifolium pratense</i> . From a Natural Pasture	2. <i>Trifolium pratense</i> . From Cultivation	3. <i>Trifolium pratense</i> Perennial. From Cultivation
<i>Heads of flowers</i> dense, proceeding from two leaves by a very short stem; 50 to 80 sessile florets of more or less lilac or pink colour	<i>Heads of flowers</i> dense, 70 to 120 sessile florets	<i>Heads of flowers</i> lax; 50 to 100 florets proceeding from leaves by an evident stem
<i>Calyx</i> of 5 teeth, the lower the longest, half the length of the flower	<i>Calyx</i> similar to 1	
<i>Corolla</i> , standard, with a long straight tube	<i>Corolla</i> similar to 1	
<i>Leaves</i> trifoliate, more or less hairy; leaflets ovate, either broadly lanceolate or notched at the apex; all having a more or less triangular white marking in their centre	<i>Leaves</i> of three leaflets more or less ovate, with the white triangular marking three times the size of 1, but less hairy	<i>Leaves</i> of three ovate leaflets, with less distinct triangular spot than 2, clothed with silky hairs
<i>Stem</i> solid, channelled or angular, purple	<i>Stem</i> sometimes fistular, more or less channelled or ribbed; mostly free from hairs; purple upwards	<i>Stem</i> variable, sometimes fistular, mostly quite round, and smooth sometimes; but not generally hairy
<i>Root</i> descending, but considerably branched	<i>Root</i> tapering with lateral branches	<i>Root</i> as 2
<i>Whole plant</i> more or less clothed with silky hairs	<i>Whole plant</i> smooth compared with 1, still more or less hairy	<i>Whole plant</i> remarkable for its hairy leaves and generally smooth round stems
<i>Height</i> from 5 to 8 ins.	<i>Height</i> 16 inches	<i>Height</i> 18 inches

- (4) Common red clover usually two or three weeks earlier in flower than cow-grass.
2. **Trifolium medium.** Zigzag trefoil. Cow-grass.
- (1) Named from bends in stem.
 - (2) Stems rounded—purple in colour, short hairs.
 - (3) Leaves smooth—Calyx smooth.
 - (4) Flower heads solitary on short footstalks.
 - (5) Bright pinkish red, not lilac.
 - (6) Found in districts free of lime.
 - (7) Suitable for sandy hills.
3. **Trifolium incarnatum.**
- (1) Large species, flower heads oblong, carnation colour.
 - (2) Found wild at Lizard, in Cornwall.
 - (3) In Southern counties can be sown by simply harrowing in on wheat stubbles, and the plant strong enough to resist winter.
 - (4) Provides early feed ; may be mown.
 - (5) Off sufficiently early for late crop of turnips.
 - (6) Able to snatch intermediate crop by Carnation clover.
 - (7) Large cropper, feeding qualities inferior to broad-leaved clover.
4. **Trifolium hybridum.** Alsike clover.
- (1) Qualities intermediate between broad-leaved and Dutch.
 - (2) Entitled from its growth, duration, and feeding qualities to high rank.
 - (3) Thins very much after second year and disappears after third year.
5. **Trifolium fragiferum.** Strawberry-headed clover.
- (1) Calyxes enlarge after flowering.
 - (2) Flowers pinkish.
 - (3) Native of cold wet pastures, hungry clays.
 - (4) Must not be confounded with Dutch clover.
6. **Trifolium repens.** White Dutch clover.
- (1) Of general cultivation, valuable plant.
 - (2) Increased in meadows by addition of nitrates, soot, &c., with guano or superphosphates.
 - (3) On very light soils, Dutch clover may be increased or wholly used.
7. **Trifolium filiforme.** Small yellow clover.
- (1) One of the least of our yellow-flowered division.
 - (2) Common native species on roadside.
 - (3) Of little flower—incapable of improvement.
8. **Trifolium procumbens.** Hop trefoil.
- (1) Small head of persistent flowers resembles the fruiting heads of hops.
 - (2) Dries up quickly under sunshine.
 - (3) Very little cultivated.

CLOVER ALLIES.

1. *Ulex*—A spinous shrub.
2. *Anthyllis*—Flowers in a dense head with white expanded calyces.
3. *Lotus*—Flowers in lax heads ; pods straight, many-seeded.
4. *Medicago*—Flowers various ; pod spirally twisted.
5. *Melilotus*—Flowers in spikes, drooping to one side ; pod straight, few-seeded.
6. *Onobrychis*—Flowers in spikes, drooping ; pod wrinkled, one-seeded.
7. *Vicia*—Flowers single or spicate in the axils of the leaves, pod straight, many-seeded.
8. *Lathyrus*—Flowers one or many on long footstalks.

1. ***Ulex*. Furze.**

- (1) Common on sandy heaths and wild places.
- (2) Possesses low feeding powers.
- (3) Young stock can scarcely hold their own upon it.

2. ***Anthyllis*. Ladies' fingers.**

- (1) Hay abundant and nutritious.
- (2) While young good for sheep pasturage.
- (3) Its want of 'proof' prevents its extensive cultivation.

3. ***Lotus*. Bird's-foot Trefoil.**

- (1) Commonly called crow's-foot.
 - (a) *Lotus corniculatus*. Common bird's-foot trefoil.
 - (1) Its herbage appreciated by sheep and cattle.
 - (2) No bad adjunct to the rick.
 - (3) Good for laying down light land for permanent pasture.
 - (b) *Lotus tenuis*. Slender-leaved bird's-foot trefoil.
 - (1) A denizen of stiff soils.
 - (2) May be employed in thin clay-beds on upland soils.
 - (c) *Lotus major*. Larger bird's-foot trefoil.
 - (1) Grows freely in moist situations.
 - (2) Capable of affording a quantity of wholesome keep.
 - (3) Might be combined with rye grass on deep stiff soils.

4. ***Medicago*.**

- (a) Yellow sickle medick.
 - (1) Heads of naked blackened uncurved seed vessels.
 - (2) Of great value in mixtures called 'seeds.'
 - (3) Good adjunct to rye grasses and common clovers.
 - (4) Smothered out by full crop of broad-leaved clover.

- (5) Yields a good crop for first two years when sown with sainfoin, and declines as sainfoin gets possession of land.

(b) Lucerne.

- (1) Perfectly perennial plant.
- (2) Deserves a greater growth in England.
- (3) Possible to cut three times in one season.
- (4) Should be grown near the stable as it has a good alterative effect on horses.
- (5) Should be grown in drills fifteen to eighteen inches apart.
- (6) Will last many years if manured.

5. **Mellilotus. Mellilot.**

- (1) Has a flavour like sweet vernal grass.
- (2) Might be mixed with seeds.
- (3) Large yields from poor stiff clays.

6. **Sainfoin.**

- (1) Cultivated on calcareous soils.
- (2) May be a permanent crop on limestone and chalk.
- (3) The seed unfortunately too often mixed with Burnet, which at the best is but a weed.

CLOVER SICKNESS.

Remedies.

1. Pare and burn the thin top soil.

- (a) Converts hard limestone brash into lime.
- (b) Opens it to the influence of air and rain.
- (c) Restores the lime and alumina.
- (d) Decomposes the vegetable humus.
- (e) All soils having excess of humus are dead and injurious to vegetation.

Analysis of Soil adapted for Burning.

Moisture	·93
Organic matter	10·67
Oxides of iron and alumina	13·40
Carbonate of lime and sulphate of lime	23·90
Carbonate of magnesia	1·10
Phosphoric acid	trace
Potash	·38
Soda	·13
Insoluble silicious matter	49·66
	100·17

- (f) Paring and burning often yields sufficient phosphoric acid to procure a crop.
- (g) The phosphorus, alkalies, and lime rendered in a fit state for the growth of plants to be grown on them.

- (h) These ingredients before the process were locked up, and are now rendered soluble.

Analysis of Soil from Paring and Burning.

Moisture	9.12
Oxides of iron and alumina	14.56
Carbonate of lime	17.17
Sulphate of lime	1.73
Magnesia	.40
Chloride of sodium	.08
Chloride of potassium	.32
Potash	1.44
Phosphoric acid	1.84
Equal to bone earth	(3.98)
Soluble silica (soluble in potash)	8.70
Insoluble silicious matter	44.74
	100.00

- (i) Destroy insect life.
 (j) Allow birds to come on freshly turned-up earth.
 (k) Do not destroy but encourage young birds and birds of prey.
 (l) Permit the rooks to come on the land.
2. Eat as much of the produce of the farm on the farm as possible.
 3. Endeavour to obtain pure and clean seed.

Parasites of Clover.

1. *Cuscuta*—*Dodder*.
 - (1) A mass of pink and yellowish tendrils.
 - (2) Has no leaves.
 - (3) Lives wholly on the juices of its foster-parent.
 - a. Methods of destruction.
 1. Examine crops in early growth.
 2. Remove by hand the wire-like tendril.
 3. Make a trench a foot wide round the plague spots.
 4. Burn straw on the dodder plot.
 5. Depasture the crop.
 6. In no case seed it down.
2. *Orobanch*e—*Broomrape*.
 - a. (1) A pernicious plant in light soils.
 - (2) Mischievous to the food and cattle.
 - b. Remedy.

Hand-pick it off.
 Noticed by the clover root being swollen at base.

PART VI.

LIVE STOCK.

Live Stock.

1. The system of farming adopted determines the kind of stock kept.
2. Whatever kind be kept, it should be of good quality and suited to the district.
3. Much of the farmer's success depends on the management of stock.
4. That which promotes their comfort increases the profit.
5. Harsh and cruel treatment decreases profit.
6. Suffering undergone involves a corresponding loss.
7. Kind treatment a foundation stone of profitable management.
8. Supply of food to be regular.
9. Its character to keep stock steadily improving.

Improvements in Breed.

1. They become more economical producers of meat.
2. The same quantity of food produces more meat.
3. The activity of the body diminished.
5. Animals indisposed to much exercise.
5. They look for the supply of food without much labour to secure it.
6. Rejoice in quiet and peaceable lives, abundant food, and least possible amount of trouble.
7. They are tender and delicate.
8. They breed with greater risk.
9. By selection you can encourage a preponderance of flesh or milk.
10. Greater economy in producing meat from vegetable food.
11. By an animal of improved breed we can convert corn, roots, and clover into meat with the least possible time and material.
12. Our several breeds of farm stock are excellent machines for production of meat.

13. This entails deprivation of energy, loss of hardy character.
14. Gives ability to control and form the domestic animal.
15. Able to produce varieties from original shape—in habits of life, in constitutional character.
16. This success not attained by sudden changes.
17. By taking advantage of favourable peculiarities.
18. Encouraging and rendering their development permanent.
19. The best quality of meat obtained by judicious crossing of pure breeds.

Fattening Process.

1. Produced from non-nitrogenous portions of food.

Starch	.	.	.	.	.	}	The chief use of these to maintain the heat of the body.
Gum	.	.	.	.	.		
Sugar	.	.	.	.	.		
Cellulose and woody fibre	.	.	.	.	.		
Oil	.	.	.	.	.		
2. Temperature of animal body higher than surrounding air.
3. 100° Fahrenheit = heat of body of ox.
4. If no internal heat, warmth would fall to that of the air.
5. This takes place after death.
6. Oxygen of atmosphere in the lungs acts on non-nitrogenous matters in blood.
7. These matters contain large quantity of carbon.
8. Animal inspires oxygen, expires CO₂, carbonic dioxide.
9. Adding oxygen to the blood the carbon is burnt or oxidised.

	Composition of atmosphere drawn into the lungs	Composition of breath thrown off from the lungs
Nitrogen . . .	79·16	79·16
Oxygen . . .	20·80	16·84
Carbonic acid gas	·04	4·00
	100·00	100·00

Conditions necessary.

1. Lungs must be sufficiently powerful.
2. Blood must contain sufficient heat-producing matter.
3. The healthy actions of the lungs upon the blood to be properly supplied with non-nitrogenous matter.
4. The demands for the maintenance of warmth are regulated by the loss of blood.
5. The colder the air the greater the demand.
6. By sheltering the animal the demands are decreased and the overplus is stored in the animal as fat.

Formation of Fat.

1. Encouraged by limited motion of the body, which decreases the waste.
2. Caused by the supply of carbonaceous food.
 - (1) To keep up the animal heat to 100° Fahr.
 - (2) Each degree of heat beyond 100° Fahr. deposits the food as fat on the animal's frame.

Management.

1. The improved breeds are delicate.
2. Require more care and protection.
3. If exposed to greater altitudes, the animals become subject to disease.
4. The conditions rendering the animals energetic are modified to make them producers of fat.
5. As we succeed so we produce delicate constitution.
6. Nature rebels against our improvement.
7. The farther we carry out the proceedings for the production of fat the more we unfit them for breeding.

Ventilation.

This should never be sacrificed for shelter and economy of food.

1. The carbonic acid exhaled is dangerous to life.
2. Its action is not immediately fatal.
3. Its accumulation on the lungs causes disease.
4. Diseased lungs from bad ventilation are on the increase ; our aim should be at progressive improvement of the growing animal.

Aims.

1. Keep constant growth by liberal and judicious, but not wasteful, supply of food.
2. Nothing is more destructive than restricting food.
3. Never be careless of shelter or bedding.
4. With abundant food attend to due exercise for growing animals.
5. A little linseed cake conduces to a healthy system.
6. As the animal grows the fat cells are formed.
7. Animals thus fed are finally fattened more economically than others on a different system.
8. Food containing the best blend of elements conducing to the animal's growth and fat pays the best.
9. Fattening process unfits the animal for breeding.
10. The more exercise is given the less fattening is the result.

FOOD OF STOCK.**Food.**

1. Numerous substances, differing in character and composition.

2. Their nutritive value affected by cultivation, soil, climate, and manure.
3. Consisting of—
 - Nitrogenous : albumen, fibrin, and casein.
 - Non-nitrogenous : starch, gum, sugar, cellulose, and oil.
4. The food supplies materials for the blood.
5. Starch, gum, and sugar, the first producers of animal heat.
6. If these be absent oil has to do the work.
7. The albumen, fibrin, and casein :
 - (a) Repair the waste of the body.
 - (b) Develop muscular strength.
 - (c) The flesh-forming matter of food.
8. Waste of body is continually going on.
 - (a) Every movement of body causes it.
 - (b) The greater the exertion the greater the waste.
 - (c) The reparation produces greater strength.
 - (d) Makes demand upon nitrogenous substances.
 - (e) The surplus available for muscular growth.
9. The mineral parts of the food supply the skeleton.

Judgment required.

1. Influenced by the knowledge of the food's composition.
2. If not a nitrogenous it is impossible to be a flesh-forming.
3. If not a carbonaceous, it is impossible to be a fat-forming.
4. The non-nitrogenous group contains carbon, hydrogen, and oxygen.
5. These are also the elements for heat producing.
6. The nitrogenous can, on emergency, slightly maintain heat.
7. The carbonaceous do not supply flesh.
8. To attempt to supply the demands of the one by giving the other will result in failure.

Changes undergone by Food.

- A. 1. Bullock has four stomachs. *Rumen*, or Panch, occupies three-quarters of whole stomach.
2. Simply used to receive fresh-gathered food.
3. Here receives moisture from saliva passing up gullet.
4. Changes the starch of the food into sugar.
5. Tossed to and fro by muscular action.
6. Gradually form pellets, which increase in size.
7. When arriving at lower end of gullet caught by muscles and sent to the mouth to be remasticated.
8. Hence chewing the cud the food is thoroughly saturated with saliva.
- B. 1. *Reticulum*, or Honey-comb, about the size of a man's head.
2. Food received from *Rumen* in a very soft state.

3. That which requires remastication returned to Rumen.
- C. *The Manyplies*, or Manyfolds. *Omasum*.
 1. Numerous folds all round, secreting mucus.
 2. The starchy matter in food more completely changed into sugar.
 3. The softened, sweetened food, a semi-fluid mass.
- D. *The Abomasum*, or true digestive Stomach. Largest in the calf, called the Keslup or Rennet.
 1. Lined by a membrane which pours out gastric juice.
 2. A clear colourless liquid of acid taste. Hydrochloric acid, and lactic acid ($\text{HCl} + \text{C}_3\text{H}_5\text{O}_3$).
 3. Quite opposite in character to saliva.
 4. Contains *pepsin*, the active agent in digesting and solving the albumen of the food.
 5. Converts the flesh-forming food into a chyme.
 6. *Chyme* is the original food softened, finely divided, its starch changed into sugar, and the nitrogenous portions brought into solution.
 7. Here food passes to highest part of small intestine.
 8. Mixed with bile from the liver, and pancreatic juice from sweetbread.
 9. The former is a soap with an excess of soda. The latter colourless, transparent, changes remaining starch into sugar.
 10. The bile acts on the oily matter floating in the chyme, emulsifying it, and changes the chyme into chyle.
 11. Nutritious portions of food now absorbed by lacteals and carried into the blood.
 12. Here keeps up animal heat.
Rebuilds wasted tissue.
Produces new tissues.
Stores up fat.
Inorganic matter also enters into the blood.
After useful portions have been taken the cellulose and woody fibres pass into excrement.

Blood.

1. Its duty commences in the lungs and bloodvessels.
2. Here carbonic di-oxide (CO_2) formed, keeps up heat of blood and animal.
3. From the lungs the heart pumps blood through arteries.
4. These terminate in hair-like tubes, called capillaries, and form a complete network round the body.
5. The serum of the blood containing fibrin in solution exudes from the capillaries.
6. This serum used by living tissue to grow upon.
7. The oily matter in the blood so rendered available for growth of fat.

Growth of Body.

Depends on the food eaten and general condition of health.

Food.

- A. Carbonaceous, heat-giving, or amyloids and fat-forming ;
or non-nitrogenous, oil, starch, gum, sugar, cellulose.
- B. Nitrogenous, flesh-forming albuminoids, albumen, fibrin,
casein.
- C. Alkaline—Potash, soda, lime, magnesia.
(A. and B. should be given in such proportions and
combination so as to be productive of good effect.)
- 1. If A., starchy matter, be given in a raw state for any length
of time, the stomach will be deranged, food fermented,
stomach distended, by evolution of poisonous gases, and
death will be the result.
- 2. If oily matter not relished produce diarrhoea.
- 3. If B. be injudiciously given, congestion of heart and lungs
—diarrhoea, inflammation of bowels, and death.
- 4. C. necessary to sustain balance between solids and fluids.
(a) Blood contains fifty-five per cent. common salt (NaCl).
(b) Common salt (NaCl) necessary for distribution and
laying on of fat.

FACTS TO GUIDE THE GROWER OF BEEF.**A. The purpose of Cattle-feeding.**

- 1. To obtain the largest quantity of the best quality of beef
at the least cost under three years of age.
- 2. To aim at breeding, raising, and fattening one cattle
beast from every cultivated four acres.
- 3. To grow as great a variety of the food required for these
purposes ourselves as the climate allows.
- 4. The live weight of the animals to be not less than
1,280 lbs.
- 5. The nett cost of production, giving credit for manure, not
to exceed 3d. per lb. live weight.
- 6. To obtain one ton of manure per month from each beast
over two years old when stabled to finish the fattening
process.
- 7. The value of such manure, under the best management, to
be made worth four shillings per ton.

B. The Animal in Cattle-fattening.

In any class it is desirable to have :

- 1. First cross between pure breeds.
- 2. A certain age.
- 3. A quiet disposition.
- 4. Quality as indicated by fine head and ears, fine bone,
horn in horned cattle, tail and a medium thick skin,
plenty of fine soft silky hair with mellowness.

5. A weight-carrying frame.
6. Animal capable of good development on good pasture.
7. Giving best quality of flesh with least of offal.
8. Sure breeders and good nurses.
9. Shorthorns best for weight, early maturity, and first cross for quality of beef.
10. Herefords—hardiness and grazing.
11. Aberdeen Poll—even average for all requirements.
12. Galloway—extreme hardiness and quantity of flesh.
13. Devon—good nursing and sure breeding.

C. Food for Fattening Cattle.

1. Calculate on getting 1 lb. of flesh from any food containing 10 lbs. of dry substance in composition.
2. A mixture of Indian corn, linseed cake, beans, better than corn alone.
3. The daily increase from birth to ripeness ought to be $1\frac{1}{2}$ lb.
4. At three years 1,600 lbs., two and a half years 1,360 lbs., and at two years 1,100 lbs. live weight.
5. Good mixture of grasses and clovers give greater daily increase.
6. On good pasture grain does not add correspondingly to weight.
7. Good shelter and water add material success.
8. Soiling fattening cattle—produce one animal per acre—crops, corn, lucerne, red clover, tares, oats, rye, and rape.
9. To fatten for show, soil in loose box all summer, and add grain.
10. A limited quantity of straw cut and slightly fermented is decidedly beneficial.
11. Green oat straw + pea straw = in value poor meadow hay.
12. 35 lbs. swedes + 6 clover hay + $2\frac{1}{2}$ oil cake produce 1 lb. beef.
13. 1 ton fermented cut straw, 200 lbs. oil cake = 1 ton hay.
14. 6 lbs. hay, 1 lb. bran, 20 lbs. turnips, 5 lbs. corn, produce 1 lb. beef.
15. 6 lbs. pea meal = the corn in the above.
16. $7\frac{1}{2}$ lbs. crushed oats = the peas or corn in above.
17. Corn, peas, oats, barley, will pay to fatten when not more than $\frac{1}{2}$ d. per lb.
18. Barley meal gives fine finish, sleek mellow handling.
19. In soiling, green fodder is safer when cut and mixed with cut straw or hay, and allowed to slightly ferment and sprinkled with meal.
20. All animals fatten cheaper and faster on prepared food.

21. Every cud-chewing animal must have bulk of food ; the stomach must be filled to give material for ruminating.
22. Foods are better in combination than alone.
23. Fat and flesh-forming food together give 60 per cent. more than when given singly.
24. To young cattle 6 flesh to 1 fat-producing food.
To old cattle 1 flesh to 8 fat-producing food.
25. Exclusive of water, an animal at maturity will eat $\frac{1}{50}$ of its weight per day.

D. Management of Fattening Cattle.

1. Give the animals as much as they will eat, and often five times a day.
2. Often change the food but not rapidly.
3. Give 1 lb. grain per day to every 100 lbs. of their weight.
4. Give as much water and salt as they will take, or
5. Give as many roots as will not necessitate drinking water.
6. Currying and cleaning tend to more rapid increase of weight.
7. The growing animal requires a little exercise daily.
8. Temperature not less than 75°, not more than 105°.
9. External evidences of primeness: full rumps, flanks, shoulder vein, well covered rib, and good forecrop.
10. A good cattle-man means $\frac{1}{4}$ gain.
11. Never begin fattening without a definite plan.

RESULTS OF EXPERIMENTS ON CATTLE FEEDING.

1. Corn and grass newly cut and drawn from the field and made into ensilage can be done at a cost not exceeding 25s. per ton exclusive of cultivation.
2. In competition with swede turnips, ensilaged fodder gives 15 per cent. less milk, 30 per cent. less butter, and a poorer marketable butter in colour.
3. Damaged wheat can be economically used in cattle fattening. 9 lbs. per day gave a daily increase of 2 lbs. per head per day, at a cost of 3d. per lb. to the live weight.
4. Rice meal gives a daily increase of 1·81 lb. per head per day by the use of 6 lbs. per head per day, at a cost of about 3d. per lb. dead weight.
5. *Barley meal* requires a large amount of other foods in association, and 11½ lbs. per head per day give a daily increase of 2·14 lbs. per head per day, costing 3½d. per lb. live weight.
6. *Corn meal* takes the highest place in a daily rate of increase ; 9½ lbs. per head daily give 2·31 lbs. per head daily, costing 2¾d. per lb. live weight.
7. *Pea meal* gives the second best rate of increase at the *least* cost of all the regular cattle-feeding grains. 8½ lbs.

per head daily gave a rate of 2.28 lbs., at a cost of $2\frac{1}{2}d.$ per lb. of weight added to animal.

8. A *pure-bred Shorthorn* steer can be brought to 1,700 lbs. weight when one month under 2 years old, or a daily increase of $2\frac{1}{2}$ lbs.
9. *Hereford* steer calves can be made to average 611 lbs. gain in 238 days, or at $2\frac{3}{4}$ lbs. per day.
10. *Aberdeen poll* steer calves, 720 lbs. in 273 days, or $2\frac{3}{4}$ lbs. per day.
11. During winter a 1,000 lbs. *steer* will daily consume 10 lbs. hay, 39 lbs. turnips, 4 lbs. bran, and 9 lbs. of mixed grain, gaining 2.11 lbs. daily.
12. One lb. of added weight to a 1,000 lbs. *steer* can be obtained from 11 lbs. chemically dry food.
13. *Sugar beet*, weight for weight with mangolds and turnips, and in association with equal kinds and quantities of other food, gave the highest returns in feeding, viz. 2.7 lbs. per head daily.
14. *Mangolds* gave 2.38 lbs. per head daily.
15. *Swede turnips* gave 2.3 lbs. per head daily.
16. There is either a simple natural reason, or a hidden chemical one, in the fact that by the use of less grain and more roots, cattle gave a greater daily return in live weight.
17. From nearly 5,000 observations the following notes have been obtained.
 - (a) There is no such class as a 'general purpose' breed, one to do the best for the dairyman and the butcher.
 - (b) The *shorthorn* comes nearest up to these requirements.

Food for fattening Beast under ordinary circumstances.—

The animal should be prepared for this stage under ordinary circumstances as age, &c., the process to continue for two months.

Daily Supply.

Meal—Indian corn.	.	.	4 lbs.	} = { 80 lbs., containing dry food 28 lbs.
Oats	.	.	2 "	
Oil cake.	.	.	3 "	
Bran	.	.	3 "	
Hay	.	.	12 "	
Swedes or mangolds	.	.	56 "	

Daily Cost of Cattle Feeding.

Age . .	Calf			Three months			Six months					
Hay . .	—	£	s.	d.	$\frac{1}{2}$ stone	£	s.	d.	$\frac{1}{2}$ stone	£	s.	d.
Straw . .	$\frac{1}{4}$ stone				$\frac{1}{4}$ "				$\frac{1}{4}$ "			
Turnips	—				$\frac{1}{4}$ "				$\frac{1}{4}$ "			
Meal . .	$\frac{1}{4}$ lb., last mo.				$\frac{1}{4}$ lb.				$\frac{1}{4}$ lb.			
Milk . .	(1st. mo., 5 qrts. 2nd. mo., 6 qrts. 3rd mo., qrts.)				4 qrts.				4 qrts.			

Age . .	Yearlings				Cow in calf				Newly calved			
Hay . .	1 stone	£	s.	d.	1 stone	£	s.	d.	2 stones	£	s.	d.
Straw . .	1 "				3 "				1 "			
Turnips	1½ "				4 "				—			
Meal . .	2 lbs.				—				10 lbs.			

Give $15\frac{1}{2}$ quarts.*Daily Food and Milk Produce of a Cow.*

Milk	5 quarts	6 quarts	7 quarts
Turnips . .	4 stones	2 stones	—
Meal . .	10 lbs.	12 lbs.	14 lbs.
Hay . .	1 stone	1 stone	1 stone
Straw . .	1 "	1 "	1 "

PART VII.

*MISCELLANEOUS ANALYTICAL TABLES, ETC.***MONTHLY ROUTINE ON A CUMBERLAND FARM.****January.**

Manure remainder of stubbles, and plough in for green crops. Commence ploughing lea lands for oats. Cut and cast up thorn fences where required. Thrash corn and attend to the fattening of stock.

February.

Sow spring wheat after turnips are eaten off by sheep. Plough lea lands. Pay careful attention to stock.

March.

Commence sowing oats. At latter end plant early potatoes. Put all fences into thorough repair for ensuing season. Pay careful attention to stock, especially to ewes about to lamb.

April.

Sow remainder of oats. Plough and well clean all lands intended for green crops. Plant potatoes. Sow grass seeds. Commence rolling and finish all grain crops towards latter end on heavy lands. Commence shearing fat hogs.

May.

Sow mangolds and swedes for early use. Get land ready for common turnips. Finish rolling corn crops. Shear store hogs. Turn cattle out to graze.

June.

Sow remainder of swedes in first week ; all kinds of common turnips during remainder of month. Cleanse and lime-wash all cattle sheds. On wet days thoroughly cleanse and repair all implements used in the cultivation of the land, and put them carefully by. Finish shearing sheep. Hoe potatoes and roots as are ready. Cleanse grain crops from weeds.

July.

Cut, make, and cart hay. Hoe potatoes. Continue with root crops as in last month. Dip the sheep.

August.

Finish cutting, making, and carting meadow hay. Finish working all green crops. Trim all fences. Commence early harvest. In wet weather thrash out all old grain.

September.

Be busy with harvest, cutting and carting; prepare for thatching stacks. Clean all stack yards; clean and put by reaping implements. All operations according to weather.

October.

Dig up potatoes and secure them from frost. Cut, cart, and cover up turnips, mangolds, intended for winter use. Cart manure, sow wheat, attend to sheep folded on turnips. Scour ditches and see that drains are open.

November.

House and attend to all cattle. Thrash corn. Sow wheat. Plough stubble. Cut and dress fences.

December.

Generally a slack time for out-door work; weather permitting, do as in preceding month.

MANURIAL CONSTITUENTS.

Natural Manures and their Comparative Values when Fed in a Natural Way.

Value per ton in Sh.		Principal Constituents per Ton in lbs. and per cent.		
		N	K ₂ CO ₃	Soluble Phosphates
5	Horse dung . .	10	8	17
4	Cow dung . .	6	2	8
5.3	Sheep dung . .	12	3	15
6	Pig dung . .	13	6	20
14	Horse urine . .	36	35	—
7	Cow urine . .	14	33	—
18	Sheep urine . .	44	51	—
5	Pig urine . .	10	19	3
5	Fresh farmyard manure (rotted)	10	13	10
6	Farmyard manure (ordinary) .	14	12	15
6	Liquid manure .	3	11	—

Fattening and Flesh-forming Qualities of Feeding Stuff.

Manurial value in Sh. per ton	Foods	Flesh forming	Fat forming	Total
75·8	Linseed cake	28	56	73
88·9	Rape cake	31	53	78
106·6	Decorticated cotton cake	41	57	82
58	English cotton cake	24	46½	61
98	Decorticated earth nut cake	39	45	72
50	Undecorticated earth nut cake	20	40	54
27	Wheat	12	67	82
25	Barley	12	67	82
30	Rye	11	72	80
23½	Oats	12	63	79
20	Buckwheat	9	60	69
18	Dari and millet	8	76	85
25	Indian corn	12	68	80
62	Beans	22	46	74
62½	Peas	22	60	79
73	Tares	27½	57	79
18½	Locust beans	7	72	82
57½	Linseed	23	112	82
25	Rice meal (best)	6½	77	83
15	Rice meal (inferior)	4	46	56
34	English palm nut meal	16	98	82
28	Foreign palm nut meal	14	76	81
55	Bran and pollard	31	54	76
26	Malt	9	76	81
71	Malt dust	26	60	87
12	Brewers' grains	6½	18	25
40	Desiccated grains	16	70	87
7	Potatoes	3	17	22
5	Mangold and kohl-rabi	2	8	12
4	Carrots	1	7	10
4½	Swedes	1	7	9
4	Turnips	1	5	7
No appre- ciable value	Molasses	{ vary as proportion of sugar from 50 to 75 per cent.		
15	Hay	8	50	64
8	Straw	3	16	22

Artificial Manures.

Value in Sh. per cwt.		Principal Manure Constituents per cwt. in lbs.				
		N	K	Soluble Phosphate	Insoluble Phosphate	Insoluble Guano Phosphate
11	Bones	4½-4·02	—	—	56-50·4	—
9	Dissolved bones . .	3-2·81	—	21-18·85	14-12·5	—
8	Bone super	1-·87	—	33-29·2	16-13·56	—
6	Mineral super . . .	·28	—	31-27·5	7-6·25	—
16	Peru guano	12-10·4	—	—	—	29-26
16	Ohlendorff's guano . .	10-9·06	—	24-21	—	4·4
17½	Ichaboe guano . . .	14-12·34	—	—	—	22-20
24	Sulphate of ammonia .	22-19·6	—	—	—	—
19	Nitrate soda	17-15·5	—	—	—	—
7	Rape cake	5-4·9	—	6-5·63	—	—
8	Shoddy manure . . .	7-6·58	61-54·4	—	—	—
12	Muriate of potash . .	—	17-15·2	—	—	—
4	Kainit	—	—	—	—	—

Manurial Constituents in Average Crops.

Crops	Quantity per acre	Weight in lbs.	Nitrogen	Potash	Phosphate Soluble
Wheat	36 bshls.	2,160 grain, 4,320 straw	60	35	62
Rye	36 "	1,944 " 5,832 "	51	55	61
Barley	50 "	2,600 " 3,250 "	54	43	54
Oats	60 "	2,400 " 4,000 "	63	49	43
Beans	30 "	1,980 " 3,465 "	137	113	90
Peas	50 "	3,200 " 6,400 "	181	100	114
Vetches	40 "	2,540 " 5,080 "	173	82	99
Buckwheat . . .	30 "	1,500 " 2,000 "	48	51	41
Flax	20 "	1,280 " 4,480 "	49	70	82
Hops	20 cwt.	2,240 lbs.	129	158	186
Meadow hay . .	40 "	4,480 "	67	67	39
Clover hay . . .	50 "	5,600 "	140	73	70
Sainfoin hay . .	40 "	4,480 "	99	80	46
Potatoes	8 tons	17,920 tubers, 6,720 tops	100	116	85
Turnips	25 "	56,000 roots, 13,440 "	141	205	100
Swedes	20 "	44,800 " 11,200 "	132	116	90
Mangolds	32 "	71,680 " 15,680 "	226	247	168
Sugar beet . . .	18 "	40,320 " 8,960 "	91	197	122
Carrots	20 "	44,860 " 11,200 "	151	185	159
Kohl-rabi	20 "	44,800 " 11,200 "	151	260	207
Cabbages	35 "	78,400 lbs.	188	470	341

Thompson's Cow.

	1 Per Day	2 Per Day	3 Per Day	4 Per Day
Food	Oats 7 lbs.	Cotton ck. 7 lbs.	Oats 3 lbs., cott. ck. 3 lbs.	Cott. ck., oats, palm nut meal, each 2 lbs., 6 lbs. per day given in three equal quantities
Butter Quality	7 lbs. per week Light, soft	7 lbs. per week Dark, firm	10 lbs. per week —	14 lbs. —

Irish Shorthorn.

Commenced two weeks after calving. Each trial of two weeks. Changed back to No. 1, dropped in quantity to 5 lbs., went back to No. 4, 13 lbs. Milked up to one month before calving.

Result of nearly 5,000 tests. Prof. Brown, Ontario.

Breed	Average weight of cow	Duration of milk- ing season	Milk per season	S. G. of milk	Per cent. cream	Cream by weight	Butter from		Cheese from milk	Value per season			
							Milk	Cream		Milk	Cream	Butter	Cheese
Shorthorn	1,570	170	2,250	97	10 $\frac{3}{4}$	8 $\frac{3}{4}$	4 $\frac{1}{2}$	—	12	19	11	22	30
" Grade	1,450	220	3,960	106	8 $\frac{1}{2}$	5 $\frac{1}{2}$	2 $\frac{1}{2}$	46	11	30	10	18	42
Aberdeen	1,300	170	2,380	111	7 $\frac{1}{2}$	6 $\frac{1}{2}$	3 $\frac{1}{2}$	40	11 $\frac{1}{2}$	18	7 $\frac{1}{2}$	16	27
" Poll Grade	1,150	190	3,040	199	4 $\frac{1}{2}$	6 $\frac{1}{2}$	—	—	—	23	9 $\frac{1}{2}$	—	—
Hereford	1,310	180	2,340	97	5 $\frac{1}{2}$	4 $\frac{1}{2}$	2	50 $\frac{1}{2}$	11 $\frac{1}{2}$	17	5 $\frac{1}{2}$	11	26
" Grade	1,100	200	3,570	106	13 $\frac{3}{4}$	6 $\frac{1}{2}$	2 $\frac{1}{2}$	40	7	27	11 $\frac{1}{2}$	18	26
Devon	1,050	200	2,800	113	7 $\frac{1}{2}$	8 $\frac{1}{2}$	3 $\frac{1}{2}$	—	16 $\frac{1}{2}$	21	11 $\frac{1}{2}$	19	45
Galloway	1,250	190	2,470	105	2 $\frac{1}{2}$	6 $\frac{1}{2}$	—	—	9 $\frac{1}{2}$	18 $\frac{1}{2}$	8	11	23
Ayrshire	1,000	210	5,250	101	6 $\frac{1}{2}$	8 $\frac{1}{2}$	3 $\frac{1}{2}$	—	11 $\frac{1}{2}$	39	21	35	58
" Grade	1,030	220	4,400	102	4 $\frac{3}{4}$	5	—	—	—	33	11	—	—
Jersey	740	200	2,500	103	34 $\frac{1}{2}$	37	—	—	—	19	—	—	—
Canadian	950	240	4,800	59	6 $\frac{1}{2}$	8	—	—	11 $\frac{1}{2}$	36	19 $\frac{1}{2}$	29	54

Milk Composition.

Water	87.24	
Casein	4.80	Flesh forming.
Butter	3.00	Fattening substance.
Milk and sugar	4.40	
Phosphate of lime		
" magnesia	0.35	Bone forming.
" iron		
Chloride of potash (K) and sodium (Na)	0.17	Blood forming.
Sodium with casein	0.04	

Circulation of Nature.

	<i>Takes in</i>	<i>Produces</i>
The plant	{ Nitrogen in the forms ammonia (H_2N) and nitric acid (HNO_3) from soil. }	{ Gluten }
Animal	{ (a) Gluten into stomach in its vegetable food and oxygen (O) through lungs. }	{ (a) Muscle and other tissues. }
	{ (b) Animal muscle, &c. into the stomach in its animal food and oxygen through the lungs. }	{ (b) Urea, &c. in the liquid excretions. }
Soil	{ Urea, and other animal excretions; dead animals and plants. }	{ Ammonia, nitric acid, and other compounds containing nitrogen. }
Plant	{ Carbonic dioxide (CO_2) by the leaves; water (H_2O) by roots. }	{ Oxygen from leaves }
Animal	{ Starch and fat into stomach, oxygen into the lungs. }	{ CO_2 , H_2O , from skin and lungs; fat in animal body. }

PART VIII.

QUESTIONS FOR EXAMINATION.

1. Of what materials are soils generally composed, and what are the chief points of difference between the composition of a good soil and a poor soil?
2. Do plants obtain all their nourishment from the soil? If not, state what is obtained from any other source.
3. Why are some crops grown more perfectly on some soils than on others? Give examples.
4. What are the materials in vegetables which are most useful for the production of flesh, bone, and fat in the animals using them as food?
5. Give examples of the manner in which you would supply any materials known to be deficient in the soil?
6. Explain the general action of lime as a manure.
7. On what principles would you regulate the succession or rotation of crops?
8. How do tillage operations—such as ploughing, harrowing, rolling, &c.—increase the fertility of a soil?
9. Are there any—and if so what—advantages to be gained by growing ‘root crops’ instead of leaving the land in ‘bare fallow’?
10. Does any injury arise to a growing crop by reason of the land not being properly drained? If so, explain the cause of such injury.
11. What general rules ought to be observed in the selection and use of food for cattle when fattening?
12. What is the difference between the shape and touch of a well-bred animal, and one of the unimproved or common breed, and how is it the one is more valuable to a farmer than the other?
13. How would you classify soils by the chemical constituents they contain, and by their physical conditions, and how do these influence their agricultural value?
14. Describe the materials necessary for the growth of

cultivated crops, their sources of supply, and the condition in which plants receive them.

15. Explain the influence of soil and of climate upon the degree of perfection obtainable in a plant's growth.

16. Explain the principles regulating the selection and economical use of artificial manures.

17. In returning to the soil the mineral matter removed from it by the bones of animals reared thereon, what materials are used for the purpose, how are they prepared for use, and in what chemical condition is it desirable to apply them to the soil?

18. How can you regulate the fermentation of farmyard manure, and under what circumstances should it be more or less fermented before it is applied to the land?

19. Give a course of cropping suitable for heavy land and another for light land, show the relative advantages of each course, and give your reasons for considering them suitable for these soils.

20. Trace the chemical and physical changes which arise in the disintegration of a rock into soil, show how these changes arise, and the manner in which cultivation renders the soil more available for vegetable growth.

21. Describe the practice of 'bare fallowing' land, explain the reasons which have led to the growth of root crops instead of bare fallows, and indicate the advantages and disadvantages arising from this change of system.

22. Explain the advantages arising from land drainage, and the consequent changes effected in the chemical composition of the soil and in its physical conditions.

23. How would you vary the general management and the food of cattle according as they may be young growing animals, breeding stock, or fattening for sale? Give your reasons for such variations.

24. State the advantages arising from keeping well-bred stock, the difficulties which specially accompany such stock, and the best means for preventing or overcoming these difficulties.

25. How would the course of husbandry most desirable for a farm be influenced by the character of its soil and climate?

26. Describe the circumstances under which water may become injurious to the fertility of the land, and how it may be employed to increase its productiveness, giving an explanation of the principles involved.

27. Trace the changes which vegetable matter undergoes from its original condition in the plant until it forms part of the structure of the living animal.

28. What changes take place in the malting of barley, what are the relative qualities of malt and barley as food, and on what *principles* should the use of malt be regulated?

29. How does a good pedigree influence the profit of the production of meat, and what are the dangers to be avoided?

30. What are the relative advantages of enriching the land by the direct application of artificial manure, and by the production of additional manure by the use of artificial or other food?

31. Can artificial manures be employed so as to impoverish the land; if so, how would you avoid such injurious results?

32. What circumstances influence the duration, quantity, and quality of the milk of a breeding animal, and how may these results be controlled?

33. Mention the various descriptions of soils, and the manner in which you distinguish them from each other.

34. Why do soils differ in their productive powers?

35. What do you understand by a rotation of crops, and why is this necessary?

36. Why is the use of farmyard manure so generally valuable in increasing our various crops?

37. Do you know of any other manures which are used upon the land, and the reasons for selecting any of them for particular crops?

38. How does drainage of land improve its fertility?

39. Give the general composition of milk, and state why it is a good food?

40. Compare the composition of milk with that of other kinds of food, and show the advantages of each.

41. What rules would you follow in selecting the best food for fattening animals?

42. How does lime act as a manure?

43. What is the difference between the active and dormant materials in a soil?

44. How can they be changed from one condition to the other?

45. What circumstances and conditions regulate the fertility and barrenness of soils, and how may the latter be overcome?

46. Explain the manner in which tillage operations render soils more productive?

47. Take any one of our ordinary farm crops, and show the conditions most favourable for its perfect growth.

48. How would you regulate the treatment of farmyard manure, so as to secure it in the best condition for use upon the land?

49. Explain the chemical changes taking place in the preparation of farmyard manure for the land.

50. What rules would regulate you in the choice of artificial manures for special crops? Give instances showing the application of such rules.

51. Explain the conditions which should regulate the rotation of crops, and illustrate the same by examples of good and bad courses of cropping.

52. State the circumstances which should regulate the choice of food for stock, and the manner in which its economical use may be best secured.

53. How is the production of wool influenced by food and general management? State what conditions favour its growth and quality.

54. Explain the influence of drainage and of irrigation upon the fertility of the soil, and any necessary connection between the two agencies.

55. What are the advantages gained by a careful control of pedigree influence in the case of cattle, sheep, and pigs respectively?

56. What are the conditions which favour the production of meadow hay of high nutritive character?

57. On what principles is our practice based for securing early maturity in stock? Show how the quality and quantity of the meat produced are influenced thereby.

58. How do you explain the tendency which exists in high-bred stock to a loss of constitutional strength, and how is this best held under control?

59. State the conditions of growth most favourable for the production of roots and corn of the most nutritive character. Give examples illustrating their successful application.

60. Point out errors of practice occasionally observed in the irrigation of land, and state your reasons for objecting to such mode of procedure.

61. What are the relative advantages of enriching the land by the use of artificial food and artificial manures respectively, and how far can the use of the former advantageously supersede the use of the latter?

62. Show the influence exerted upon the quality and character of a crop by a judicious selection of suitable seed, and the means whereby that influence is best maintained.

63. Describe the variations observable in the quality of wool, and the circumstances which influence its successful growth.

64. Give an example of the advantages arising from the application of science to ordinary farm practice, and state the principles involved therein.

65. What food do plants require for their growth, and where do they obtain their supplies from?

66. How do soils become exhausted and unable to produce good corn crops?

67. Why do we apply farmyard manure to the land, and *how should it be used?*

68. Why do farmers plough, harrow, and roll the land, and bring it into fine condition ?

69. How are soils formed ?

70. What do you know about the action of lime as a manure ? How is it used, and what good does it do to the land ?

71. Why do we drain land, and how is land improved by draining ?

72. What are the principal substances found in the different kinds of foods used for farm stock, and what is the use of each of these substances ?

73. Why is food made more useful for farm stock by protecting them from exposure to cold and wet ?

74. Why is it desirable to grow crops in a regular succession instead of growing the same crop year after year ?

75. Do sheep, eating a growing crop, return to the land in their manure all that the crop took from the land ? If not, state how any loss has arisen.

76. What are artificial manures, and why do we use them upon the land ?

77. Why do soils differ in their powers of producing good corn crops ?

78. What advantages do we gain by ploughing land so as to expose it to the cold and rain of the winter months ?

79. How do you classify and describe our various soils according to their mechanical condition and chemical composition ?

80. What duties have to be performed in the soils by manures, and why is it necessary to use the various kinds of manure commonly employed ?

81. What cheap materials are used to take the place of bones as a manure, and how are these materials most advantageously used ?

82. What substances must be present in a perfect food ? Give an instance of a perfect food, and also of food which is unable to support life.

83. What rules should regulate you in the selection and use of food for cattle, when growing, milking, and fattening respectively ?

84. Why are some animals more economical producers of meat than others ?

85. How should fermentation of farmyard manure be regulated so as to avoid any loss of its fertilising matter, and what difference would you make in the fermentation when the manure is going to be used for a sandy loam or for a clay loam, or for spreading upon clovers ?

86. Is the continuous growth of corn crops inconsistent with the general principles regulating the rotation of crops ? Explain the conditions which influence the result.

87. Why do some soils retain for the use of plants the

manures added to the soil, whilst other soils allow them to be washed away? Give instances of each, and state any means adopted for correcting this bad character.

88. State on what principle you would select manures suitable for producing grass of high feeding character.

89. How may the fertilising matter of farmyard manure be rendered slowly available for a corn crop upon light lands (such as sands and sandy loams) which possess little power of retaining manure? Describe the ordinary course of practice adopted to attain this object.

90. What phosphatic and nitrogenous artificial manures can be employed upon soils which possess little power of retaining manure, so as to secure a steady supply of each throughout the entire period of the plants' growth?

91. What are the usual causes of mildew upon root crops? Indicate some errors of practice which favour its production.

92. Why is the weight of meat produced from a given quantity of food influenced by other circumstances than the feeding powers of the animal and the quality of the food given?

93. What are the differences in form which distinguish a good feeding animal from a good milker, and how is the variation in the external form associated with the internal organism of the animal?

94. Why do some stock lose constitutional vigour? How may this loss of strength be held in check?

95. In what respects do the pedigree influences observed in seeds correspond with those in live stock, and wherein do they differ?

96. What circumstances influence the strength and even character of the fibre of wool, and also increase the weight of the fleece produced? Give instances of a want of soundness in the staple arising from bad farm management.

97. What principles would regulate you in the construction of a homestead for a clay farm, where the roots are to be consumed by cattle bred upon the farm?

98. Give an example of the advantages arising from the application of science to ordinary farm practice, and state the principles involved therein.

99. What is the difference between a sandy soil, a loam, and a clay soil?

100. What are the principal substances found in the soil, and which of these do plants require?

101. Why do we grow crops in rotation instead of continuing to grow the same crop upon the same ground year after year?

102. What is the composition of milk? State why it is such *very good food*.

103. Give a good course of cropping for a rich loam soil, and a bad course of crops for a sandy soil. State your reasons in each case.

104. What are marls, and upon what does their value depend?

105. Of what does the inorganic matter of soils consist? How does the plant get it, and why is it called the ashes of the plant?

106. How does a soil lose its phosphates? What becomes of the phosphates removed from the land, and how may they be restored to the land?

107. As the soil very largely consists of hard solid matter, how is it that plants are able to feed upon it?

108. Why are soils improved by exposure to rough and cold weather in the winter?

109. How is it that cattle, sheep, and horses are warm, and by what means is this warmth kept up?

110. Why do some animals fatten better than others when using equal supplies of food?

111. In what respect does the food of an animal differ from the food required by a vegetable?

112. What is meant by saying that 'land is sick of a crop'? Give an example, and say how it may be remedied.

113. What are the special advantages arising from autumn cultivation, and how do you explain its value?

114. Can a soil contain all the food necessary for producing good crops, and still be unable to give it to plants as food? If so, why is this, and how may it be overcome?

115. Describe how lime and farmyard manure may be used for a crop with the best results, and also how their fertilising powers may be injured by an improper mode of application.

116. A cubic foot of sand weighs about 110 pounds, and a cubic foot of clay weighs about 80 pounds. Why do we call sands light soils, and why do we call clays heavy soils? State what are the causes of the difference.

117. How do you account for the variations observed in the ashes of plants?

118. How does drainage of the land increase the quantity of plant-food ready for use in the soil?

119. What are 'reduced superphosphates,' and what is their action in the soil?

120. How are lands fertilised by irrigation, and how should the supply of water be regulated?

121. What changes does the blood undergo in its passage through the body?

122. Describe the changes which food undergoes in its digestion by a bullock and a horse, pointing out any differences.

123. In what way does climate influence the system of farm-

ing, and also the quality of the meat and corn produced? Give instances.

124. Trace the various changes which take place in a plant's growth during the time its supplies are drawn from the soil and the air, and show the disadvantages arising from the use of food which has not been fully ripened.

125. How does the condition and use of fertilisers and the character of the seed render some root crops less able to withstand the frost, and how may roots of the highest feeding character be secured?

126. How do soils retain manure, and how should light sands be treated to increase this power?

127. Describe the formation of nitre in earth, and show how soils may thus be economically enriched.

128. Describe fully the process of germination. Show how this is controlled for the production of malt, and state the conditions which regulate the quality of malt.

129. How does the blood of an animal receive fresh supplies of nutriment, how is it removed from the blood, and what determines its new form in the body.

130. How does the breathing of foul air (arising from want of proper ventilation) affect the milk produced, and the cheese and butter made from it? Are there any other means whereby similar impurities influence the milk?

131. How may the milking character of a cow be improved, how may the flow of milk be made more permanent, and its character rendered more suitable for butter and cheese-making respectively?

132. What lessons may we learn from the system of farming known as 'the continuous growth of corn,' and what are the essentials for its success?

133. Why does the drainage of land make it warmer and more fertile?

134. How does cultivation increase the food in a soil which is ready for use by growing crops?

135. How is farmyard manure frequently injured by bad management?

136. Why do soils become poor and unproductive, and how is this to be prevented?

137. Describe the manner in which our various soils have been formed, and state how you can determine whether a soil is composed principally of mineral or vegetable matter.

138. Explain the manner in which a soil should be examined so as to determine its mechanical analysis?

139. Why is it essentially necessary that plants should have a supply of phosphate, and why is so little of it present in *animal excrements*?

140. Can you name any inorganic constituent of the soil which, whilst useful for vegetable growth, is not used by our crops as plant food? If so, explain its action.

141. What duties has food to discharge in the animal body, and how does it perform its proper work?

142. Why are well-bred stock better producers of meat than unimproved cattle or sheep?

143. Of what is farmyard manure composed, and why are there such differences in its fertilising power?

144. What proof is there that different crops require different kinds of food?

145. From what sources is carbonic acid obtained by plants, and of what use is it in promoting vegetable growth?

146. Do the more abundant of the fertilising ingredients of a soil regulate its fertility, or those which are present in the smallest quantity? Give illustrations of this influence.

147. How may the fermentation of farmyard manure be made more rapid, and what precautions are then especially necessary to keep it safe?

148. Can you name any class of food which contains a very large proportion of water? If so, explain why so much water is objectionable, and show how the difficulty may be overcome.

149. Describe the various means by which a soil may be enriched by organic matter, and the advantages resulting therefrom?

150. In what condition does silica exist in different soils? Distinguish those supplies which are in a useful condition as plant food from those which are not so.

151. Does the chemical analysis of a soil always indicate to a farmer what plant food it contains? Point out the precautions which are necessary to make the analysis of a soil a safe and trustworthy guide.

152. If a soil requires lime, how would you decide whether it ought to be applied in a caustic condition, or in the milder form of carbonate?

153. Why is nitrate of soda supplied to the land, and what are the circumstances which favour its profitable use?

154. What advantages arise from a judicious cultivation of the seeds required upon a farm? Explain what is meant by pedigree influence.

155. Is the quality and yield of corn produced on a field in any way influenced by a want of proper drainage? If so, explain the difference and its cause.

156. Why is the irrigation of land favourable for an early growth, and why is that growth especially valuable?

157. Describe the changes which take place in the ripening of corn, roots, and green crops, pointing out the agencies by which such ripening is promoted?

158. Is the food produced in a mangold subject to subsequent loss by bad management? If so, explain the character of the changes by which such loss may be occasioned.

159. What are the conditions which are most favourable for the production of cheese of high quality, and for its proper ripening?

160. Describe the conditions which encourage the productive powers of the wheat plant, and improve the quality of the grain. Show why these conditions exert such favourable influences.

161. Describe the capillary powers of the soil, and show whether or not they interfere with the drainage of the land.

162. What circumstances and conditions increase or diminish the powers of a soil, for the preservation of manure in a condition favourable for vegetable growth?

163. How would you determine the character of the artificial manure most desirable for a soil?

164. Can the weight of roots (say swedes) grown per acre be taken as indicating the quantity of actual food produced? If not, explain the causes of the difference and the results.

165. How may the hereditary powers of cattle and sheep be strengthened, with the least injury to the constitutional strength of the animal?

166. State the principles which should regulate the selection and use of food, for the most economical production of meat.

167. What substances are found in our soils, and what do plants feed upon?

168. Why are some soils more fertile than others?

169. Why do we drain some of our soils, and what advantages do we gain by doing so?

170. Why is farmyard manure so generally useful for all farm crops?

171. What do you understand by the mechanical analysis of soils, how would you carry it out, and what does it help you to do?

172. What are the ashes of plants, and why do they differ in composition?

173. Describe the composition of a good food, and state what are the duties of food in the animal body.

174. Why do farmers grow their crops in a regular order, which we describe as rotation of crops? Show the difference between a good and a bad rotation.

175. How is it that a thoroughly good tillage of the soil makes the land more productive?

176. Why are phosphates used as a manure, and how should they be prepared for use?

177. How is lime used as a manure, and how should the character of the soil influence its application?

178. Can you explain how a soil may contain a large quantity of the inorganic matter needed by plants, and yet the crops may not be able to use it? How would you overcome such a difficulty?

179. What circumstances and conditions regulate the fertility of a soil, and how may unproductive soils be rendered fertile?

180. Describe the various changes effected in land by judicious drainage, and show how they influence vegetation.

181. How should farmyard manure be managed so as to protect it from loss and prepare it for use upon the land?

182. By what rules would you select the food most suitable for live stock?

183. Certain mineral matters are absolutely necessary for the growth of a crop: is a soil always fertile when such food is present? If not so, name other necessary conditions.

184. What are superphosphates, and what are 'reduced superphosphates'? Wherein do they differ in market value, and in agricultural value?

185. What are the essential conditions of a good seed-bed suitable for the growth of seeds? Give instances showing how these are secured.

186. Why is it necessary for the warmth of the body to be kept up, by what means is this done, and how does proper shelter influence the fattening of an animal?

187. Describe the capillary powers of a soil, and show the manner in which the fertility of a soil is influenced thereby.

188. Are any precautions necessary in deepening soils? If so, what are the changes which have to be secured?

189. In what way does the drainage of land influence the labour necessary for its tillage, and the condition of any live stock feeding upon it?

190. What system of management favours constitutional strength in farm stock, and how may this be explained?

191. On what principle is our practice based for obtaining early maturity in stock? Show how this practice influences the quality and the quantity of the meat produced.

192. How can artificial food be used as a cheap substitute for artificial manure. Show what fertilising agents can be most economically obtained by each.

193. How do changes of soil and climate influence the special characteristics of any breed of cattle or sheep? Give instances of each.

194. Describe the several substances of which milk is composed, and show how far simply mechanical agencies assist us in the manufacture of dairy produce.

195. What are the conditions most favourable for the production of high quality malting barley? Explain why less developed corn so often produces the best crop.

196. Mention any instance of disease in cultivated crops, explaining the causes and the best modes of prevention.

197. State the conditions of growth most favourable for the production of 'roots' and corn respectively of the highest nutritive character, and show in what respects they are frequently affected injuriously by the manures used in their growth.

198. Distinguish between powerful hereditary influence in seeds, and a strong reproductive power, and show how changes of soil and climate influence the utility of pedigree seed.

199. How may the fertilising matter of farmyard manure be rendered slowly available for a corn crop upon light lands (such as sands and sandy loams) which possess little power for retaining manures? Describe the best practice adopted for attaining this object.

200. How may hereditary character be established and intensified in farm seeds?

201. What are the principal mineral substances found in our soils, and how are they made use of by plants?

202. What do you understand by a soil becoming exhausted, and how does this condition arise?

203. What are the results we seek to secure by ploughing and moving the soil?

204. Explain the cause of wet and undrained land being colder than land which is properly drained.

205. State the chemical agencies which favour the formation of soils, and show how the same results are promoted by mechanical agencies.

206. What substances are selected as a standard whereby we can classify our soils? State why these substances are so selected.

207. Distinguish between the 'active' and the 'dormant' matters in the soil, and show how they change from one form into the other.

208. A crop of turnips being grown on a field, and eaten upon that field (say by sheep), what does the soil gain and what does it lose?

209. Describe the conditions necessary for securing a safe fermentation of farmyard manure.

210. Why are phosphates so generally necessary and useful as manures for the land?

211. Nitrate of potash being too expensive to be purchased for manure, what other means have we for securing a cheap supply of it?

212. When should lime be used upon the land in a caustic condition, and when in the form of a carbonate? Show how each form is obtained for use.

213. Do our crops differ much in their demands upon the soil? Mention those which are most exhausting in their character.

214. Describe the changes taking place in a seed during germination, and state the conditions which most perfectly favour plant growth at this stage.

215. How is the warmth of the animal body kept up to a healthy standard, and why is shelter more necessary for our 'improved breeds' of cattle and sheep than for others?

216. Describe the course of procedure you would adopt to prevent the exhaustion of the plant-food present in a soil, and state your reasons for taking this course.

217. Describe any injuries which farmyard manure is likely to suffer when it is kept without proper protection from the rainfall, and also when it is kept in covered yards. Show how these losses should be prevented.

218. What are the special advantages arising from the growth and use of green manures, and under what circumstances may they be rendered advantageous and economical fertilisers?

219. What is pedigree influence in a plant, and how may it be established?

220. Point out the essential conditions involved in the good management of a flock, wool being the chief consideration.

221. By what means were our 'improved breeds' of cattle and sheep modified in shape and character?

222. Is there any difference in the feeding power of our 'root' crops at different stages of their growth? What plan would you adopt to find out whether they are, or are not, good food for live stock?

223. Has any difference been observed in the quantity of meat produced from a given quantity of food, as it may be more or less associated? If so, on what principle should this mixture be based?

224. How does the rate of food supply, and the regularity of that supply, influence the quantity of meat produced from a given quantity of food?

225. Give an outline of the principles involved in the cultivation of corn crops and pasture grasses respectively, showing how far they correspond, and wherein they differ from each other.

226. What changes take place in the composition of hay after it has been placed in the stack? Distinguish between those which are beneficial, and those which are injurious, pointing out the principles which should regulate our practice.

227. How have wild plants been improved so as to become suitable for cultivation? Why is care necessary to prevent their degenerating, and how should it be exercised?

228. Why are various breeds of cattle and sheep desirable? State the advantages which are respectively secured by each, showing how we may determine the extent to which their special points of character may be advantageously encouraged.

229. What are the several causes which influence the character of the herbage found upon grass land? How may we best secure favourable influences, whilst guarding ourselves from those of an injurious character?

230. How do you explain the fact of our several varieties of farm seeds having to be sown at different depths and at different periods? Specify any disadvantages likely to result from neglecting those requirements.

231. What are the circumstances and conditions influencing the character and quality of the corn produced upon any farm? On what principles should such growth be regulated to secure the best results?

232. Describe the special uses to which our various root crops are applied, distinguishing the conditions which respectively improve and injure their feeding power and general utility.

233. Why should our system of cultivation be varied according as we may desire to produce high quality feeding barley, or a crop especially suited for malting purposes? Show wherein such crops differ.

234. What are the advantages arising from using artificial food as a means for enriching the land? Specify what fertilising matters can, and cannot, be economically added to the soil in this way.

235. How may we make the fermentation of farmyard manure rapid, and how can we also make it safe?

236. What are the special requirements of a good seed-bed, and why are these conditions necessary?

237. What are the advantages we gain by the tillage of the land, and how may they be explained?

238. How is the carbonic acid of the atmosphere made use of by plants, and what do plants gain by its use?

239. What do you understand by a rotation of crops, and why is this practice desirable?

240. What changes do limestone and chalk undergo in being burnt in a kiln, and what advantages do we gain by making them into caustic or quicklime?

241. When should carbonate of lime be used in preference to caustic lime, and how may the advantages be explained?

242. On what soils are the advantages of fallowing the greatest, and why are these improvements specially seen on these soils?

243. Describe the composition of a perfect food, and show how the several duties have to be performed by it?

244. What are artificial manures? Explain why we use them on farms.

245. Why do we drain some of our fields, and in what way does good drainage cause an improvement in their fertility?

246. How does a soil lose its phosphates, and how should the loss be made good to the land?

247. How is the organic matter of the soil formed, and what do you know of its composition?

248. Enumerate the means at our disposal for improving the physical character or texture of soils.

249. How does the character of the land influence the general management of the farmyard manure to be used upon it, and why is this?

250. What are the chief sources of phosphatic, potassic, and nitrogenous manures? To what crops, and in what quantities per acre, are these classes of manures applied?

251. What does the soil gain, and what does it lose, by our growing a crop of spring feed, and having it afterwards fed on the land by sheep?

252. Upon what conditions of soil and subsoil ought depth and distance between drains to depend in land drainage?

253. How may we increase the capillary powers of a soil, and what advantages are likely to result from such increase?

254. Construct a table showing the comparative manurial values of some ordinary stock foods after consumption by cattle or sheep.

255. Describe the changes which the iron oxides undergo in the soil, and state the duties they there perform.

256. In what peculiarities of composition and properties does the superior value of farmyard manure consist?

257. On what soils are the greatest advantages gained from autumn cultivation, and how may these advantages be explained?

258. Point out the leading differences in the preparation of the ground for the following crops:—

(1) Wheat after roots on stiff land.

(2) Wheat after lea on light land.

(3) Barley after wheat.

(4) Mangold wurzel after wheat on stiff soils.

259. Write a short account of the composition of milk, giving the percentages of the most important ingredients in good samples.

260. What are the essential differences between butter and cheese? Briefly describe butter-making and cheese-making.

261. What are the causes of rancidity and bad flavour in butter, and how may they be best removed?

262. What are the points which should be aimed at in breeding fowls for the market and for the table, and why are they desirable?

263. Do bees increase our fruit crops? If so, how is this result accomplished?

264. Show that nitrate of soda tends to exhaust the soil. Defend the use of nitrate of soda as a fertiliser.

265. Farmyard dung is of all fertilisers in highest favour among farmers. Do you consider this popular view to be correct? and if so, give your reasons.

266. Mention all the conditions necessary for the production of first-rate farmyard manure.

267. Discuss the question as to the relative advantages of manuring crops directly by chemical fertilisers, or indirectly through purchased foods consumed by cattle or sheep upon the land.

268. Prescribe proper mixtures and quantities of food for cattle and for sheep during the earlier and later stages of fattening. Also state what increase in live weight may be expected per week under each dietary.

269. Supply information on the following points connected with farm buildings, illustrating your remarks with sketches:—

- (1) The general arrangement of buildings suitable for 500 acres of tillage land, and 100 acres of grass land, upon which a dairy is kept, and the winter feeding of bullocks is carried on.
- (2) Dimensions in length and breadth for stalls in work-horse stable, cowstalls, feeding-boxes, fold yards with sheds, granaries and barns.
- (3) The section of roof suitable for the above buildings, the thickness of the walls, and their height to wall plate.

270. Explain the true meaning of the following couplet:—

‘To make a pasture will break a man,
But to break a pasture will make a man.’

271. What principles are involved in the saying that ‘lime enriches the father, but impoverishes the son’?

272. Construct rotations of crops suitable for the following conditions of soil, and give your reasons for each rotation supplied:—

- (1) Light land adapted for sheep.
- (2) Clover-sick land.
- (3) Heavy land.
- (4) Fen land.
- (5) To include a share of potatoes.

273. Upon what natural laws is the value of pedigree based? Discuss them, illustrating your remarks with reference to the improved races of domestic animals.

274. Name some of the principal varieties of wheat, barley, and oats, and state in what respects they severally differ from each other.

THE SOIL.

275. Name the different tillage implements employed upon the farm, and state the purposes which they severally serve.

276. Enumerate the various manures and fertilisers known to you, and say what quantity is generally applied of each per acre, and name the principal ingredients which they severally supply to plants.

277. State shortly how drainage, liming, and burning the soil respectively contribute to fertility.

THE CROPS.

278. Name the various crops and the extent of each you would expect to find upon a 400-acre arable farm, of light land and of heavy land respectively, in a Midland county.

279. Give a list of the crops known to you, naming the kind of soil which each prefers, the crops which it may follow and precede upon the land, the quantity of seed that is commonly sown of each per acre, and the ordinary quantity of a fair crop which may be expected from each per acre.

280. Describe the cultivation of wheat, beans, carrots, and potatoes.

THE LIVE STOCK.

281. State the daily quantities and kinds of food you would give to a farm horse in full work in October or November, to a fattening ox during the last two months of the fattening process, and to a winter cow in full milk during November or December, where quantity rather than quality of milk is desired.

282. Name as many of the foods as are known to you which are employed upon the farm besides those which are home-grown, and state the average percentage composition of each as regards oil, starch, nitrogenous substances, and woody fibre respectively.

283. Describe the whole management of milk in a well-conducted butter dairy, from the milking of the cows onward.

284. What are you likely to be doing upon an arable farm (in your own neighbourhood) during the last week of June and the first week of November respectively? State also what operations will then have been just finished upon the farm.

285. Give a short statement of the treatment necessary for grass land, both for mowing and feeding.

286. Describe shortly the general management of a herd of pedigree cattle—either Herefords or Shorthorns.

287. Describe a farm of 200 acres which you would consider suitable for keeping cows upon for milk selling in a district where there is a large regular demand for milk. Give shortly the general management of the farm and the cattle.

288. Describe the management of 2½-year-old bullocks, feeding in covered yards from November 1 until they are fit for the butcher. Give the description and quantity of food, and the probable monthly increase of live weight. How would you estimate their value for sale? How would you estimate the unexhausted value of the cake and corn consumed by them if you were quitting the farm at the ensuing Lady Day?

289. What description and quantity of grass and clover seeds should be sown on a medium soil for one year's grazing? The same for one year's mowing?

290. Give a description of manure drills—dry and with water. State their advantages or disadvantages, state for what crops they are most suitable, and what description and quantity of manure should be applied (without farmyard manure) to such crops on land in fair condition.

291. State the suitable rotation of crops on a light land farm in the Midland counties, the same on a medium soil, the same on a strong soil.

292. Give a description of land upon which sheep are most liable to fluke or liver-rot. State the best mode of prevention and of treatment.

293. Having the live weight given of fat cattle and sheep, how would you estimate the dead weight, specifying inferior quality, middling quality, prime quality?

294. Describe the most common sorts of couch, or squitch, or creeping grass, found on foul arable land. Which are the most difficult to eradicate, and why?

295. Describe the order of horse and manual operations throughout one year in the field cultivation of a farm consisting of 400 acres arable, and of 200 acres of old pasture, one-fifth mown for hay—a breeding flock kept, and half the lambs or tegs wintered.

296. Describe a good succession of crops for keeping a breeding flock of sheep on a purely arable farm from Michaelmas to Michaelmas, naming the month in which each crop should be fit.

297. Describe a good system of feeding :—

(1) Fattening bullocks in yards.

(2) Store bullocks in yards.

298. What is the proper allowance of food, and of what kinds, for a working farm horse in winter and in summer?

299. What is a fair average quantity of milk in imperial gallons, and of butter in pounds, for a Shorthorn cow of mature age to yield per week when in full milk?

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181

182

183

